

SCHRÖDINGER'S UNIVERSE

Einstein, Waves & the Origin of the Natural Laws

BY
MILO WOLFF

*This is the theory of the Universe originally
proposed by Nobel Laureates Erwin Schrödinger and
William Clifford, with concepts by Albert Einstein
and Paul Dirac.*

For those curious persons who always ask, Why?



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Schrödinger's Universe:
Einstein, Waves and the Origin of the Natural Laws

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Dear Reader:

I would like you to know a little about me, the author of this book. I was born 8 August 1923 in Verona, New Jersey where my father was an architect-builder and my mother was an artist. In those years of the Great Depression, few persons had much money, so I sought my education in bits and pieces where it could be had cheaply. Our Verona high-school principal gave me a one-year scholarship at nearby Essex Junior College. When that ran out, I studied electrical engineering at the NJ Institute of Technology, and for money I took a night job fixing test equipment in the National Union radio tube factory. When WWII began, I joined the U.S. Navy and went to radar school. I became an electronic-technician's mate on the heavy cruiser Bremerton, the flagship planned to lead the invasion of Japan. As it happened, the A-bomb ended the war and we sailed to Shanghai, China. I was the chief 'fix-it man' in the radio room repairing radar, loran, sonar, teletypewriters, coffee pots — anything.

After the war, my education was free using the GI Bill, but there was a flood of ex-GI students filling up colleges. Free places were hard to find. I studied chemistry and economics at Rutgers University and then Upsala College. BS degree in hand, I went to work for the Philco Corporation writing military radar manuals and fixing radar as a field engineer for the U.S. Navy in Great Lakes, Illinois.

I am a person driven by curiosity, wherever it leads — although this has not always been wise. As I learned, my curiosity demanded to know all the reasons why scientific and technical apparatus worked. I never felt I knew enough, so I decided to use the last of my GI Bill at the University of Pennsylvania to study physics and EE. For my PhD thesis (still a fix-it man!), I helped build a Van de Graff accelerator and did an experiment shooting tritium atoms at carbon and oxygen targets. During summer vacations, I found a wonderful job fixing sailboats at *Alliquippa* — a kids camp in Small Point, Maine. This was a happy time; I loved the kids and they loved me, and we had a grand time playing, sailing, fishing, and eating lobsters. View those memories at www.Alliquippa.net.

PhD in hand, I was hired by the University of Kentucky to teach at the Bandung Institute of Technology in Indonesia. During my four years there I learned to speak and teach using *Bahasa Indonesia*. I was also fascinated by the cultural attitudes of other people; learning and living a new language became a 'mirror' in which I could see glimpses of my American culture against a background of varied world cultures (seeing oneself is more difficult than seeing others). I married one of my students, Ching Lie. We had two children, Lan-Ling and Winston, adding to my three children, Eric, Jennifer, and Douglas, from my previous wife Bettina.

President Sukarno was in the first graduating class (1919) of this Institute, so he often brought foreign dignitaries to hear his elegant speeches to the students. He was a sensational speaker, first telling jokes in Indonesian, Javanese, Balinese, French and English, before turning serious in Indonesian.



Afterwards, he would invite us professors to lunch. At various times, he asked us to dine with Ho Chi Min, Robert Kennedy, and the Sultan of Borneo.

While in Indonesia, where teakwood is grown and is famed for boats, I hired a Dutch architect to build a sailboat for me that I named "Bettina". The boat and I, with the aid of motley crews, eventually arrived in Boston. Then, in 1963, I went to work at the Massachusetts Institute of Technology as one of 50 scientists and engineers designing the navigation system for the Apollo Moon Rocket. It successfully reached the Moon six years later.



The sailboat Bettina in the port of West Island, Sumatra, preparing for the trip across the Indian Ocean. The author is on the stern deck. We are waving to the people of the Indonesian Navy who helped with repairs.

The Apollo astronauts needed to know the structure of the Moon's surface where they would land. Was it deep dust into which the lunar vehicle would helplessly sink? It was my job to find out. In France, an astronomer, Prof. Audouin Dollfus, knew more about the Moon than anyone else, so I studied his work and became interested in an 80-year old mystery: *why does light reflected from the Moon become polarized at exactly right angles to the expected polarization plane?* Six years later I solved this mystery, and found that one could use it to determine the sizes of asteroids and moons and the type of minerals on their surface. [*Polarization of light from rough planetary surfaces*, Applied Optics 14, 1975]. The answer was very simple — light entering a rough surface of grains can reflect *twice* as well as once. The double reflections caused the mystery. This paper was re-printed by the Optical Engineering Society in their volume set, "Milestones in Optics."

Another task was to help the returning astronauts know what the Earth's horizon looked like, because it was obscured by atmospheric haze. I wrote a computer program that would scan the entire atmosphere (using a satellite circling around it) and deduce the navigational horizon hidden below. I also realized that this circling satellite and computer program could determine the chemical composition of the entire upper atmosphere. [*Precision limb profiles*



for navigation and research, J. of Spacecraft, 4, 1967]. My proposal to NASA yielded six million dollars for MIT. What I didn't realize to— my great regret — was that the same program could be used to scan the human body; it was to become the well-known CAT-SCAN. Four years later, someone else did it and made a lot of money!

On a leave of absence from MIT, obeying my travel urge, I worked two years (1966-68) as the physics Professor for the University of Sri Lanka. My task was to establish a new faculty of Science at their oldest Buddhist university—Vidyalkara. Being a fix-it man, I emphasized a program of practical technology needed by a cultured but non-industrialized nation. It succeeded, and at their 25th anniversary, I was awarded an honorary doctoral degree and was asked to give the keynote speech [Colombo Times, 1992].

The Earth is so full of interesting places that I was not satisfied to remain in just one. So in 1970 I was happy to become Foundation Professor at the University of Singapore (Nanyang) for two years. I have always been fond of Singapore because their birthday, August 8, 1963, is also mine. I was 40 years old when they separated from the British Empire... and I was in Singapore repairing my sailboat Bettina.

I returned home to join the Aerospace Corporation in Los Angeles, working with their space program and the GPS Global Positioning System—one of the most precise measuring systems on Earth. In view of its great usefulness, it is sad to see it used for war, although we always knew this was the purpose from the beginning.

In 1975, I became Chief of Science and Technology for the United Nations Economic Commission in Addis-Ababa, Ethiopia. My role was to stimulate science and technology throughout Africa — on a budget of zero dollars! Well, I learned a lot about the UN and Africa.

THE UNIVERSE IS AN INFINITE COLLECTION OF GADGETS. At age 55, I sadly realized that my ambition to learn all of technology was hopeless. Science and Technology were growing faster than either I or anyone could learn them all. So I decided to study and find the origin of just the basic *Natural Laws* that underlie science and technology. There are only about six such laws, depending on your perspective, so my goal was limited and may be possible. The result of that study is this book.

These six laws are called Natural Laws because there were no explanation of their origin. They were measured experimentally over three hundred years and algebraic equations were invented to describe them. These are the rules of electricity, magnetism, mechanics, gravity, quantum theory and relativity. The natural philosophers: Aristotle, Plato, Archimedes*, Democritus, Bhudda, Galileo, Leibnitz, Newton, Clifford, Mach, Lorentz, Dirac, Einstein, Schrödinger, etc. were also curious about them and some sought to find their origin from a single thing or cause which they labeled *natural reality*.

NOTE: *Archimedes was supported by a Greek patron of the arts named Milo of Crotona and married his daughter. Archimedes was one of the first philosophers to reject the concept that matter was composed of tiny 'particles'.

In the period 1860 to 1950, these pioneers, especially Clifford, Einstein and Schrödinger, thought deeply about the most basic assumption of the natural laws: that matter consisted of tiny discrete particles like sand. Knowing the experimental properties of matter, they concluded that this particle concept was wrong. Whatever it was, it had to interact with other matter. Matter cannot be separated from the space it occupies. They realized that *space was not empty* and instead, waves within it had the properties we experience as mass and charge. However, after WWII, the origin of the natural laws and the structure of matter were almost forgotten. Scientists had lost their interest in science! Instead, radar, transistors, computers, bombs and high-energy occupied the center stage of physics, as shown in the cartoon below.

Physics 1950 A.D. • Which Road?



In my previous book, *"Exploring the Physics of the Unknown Universe"* (1990), I explained my curiosity by writing about science not yet known, rather than reviewing the standard dogma. In it I proposed a wave structure of the fundamental particles: electrons, protons, and neutrons, because this seemed to be the simplest way to explain the paradoxes. Amazingly, it has turned out that all the natural laws were contained in that wave structure. It slowly

dawned upon me that the long-sought *one thing* the origin of all scientific laws had been found. Finding this was a lucky coincidence. In fact, I began the work to only satisfy my curiosity of the origin of quantum mechanics (QM), especially its simplest basis, the deBroglie Equation $\lambda = h/p$, which states that a moving particle has a wavelength inversely proportional to its momentum p . I was not aware of the vast implications that would be revealed for the whole Universe.

After WWII, the physics community offered new sources of energy, micro-chip devices, and applications of radar to the government. They had been very successful in the war, so the government eagerly financed them. Those that were economically viable were snapped up by industry but expensive particle accelerators remained, along with the paradoxes of particulate matter.

I had been curious about the meaning of the deBroglie wavelength ever since my first course in quantum theory at the University of Pennsylvania but I never dared ask this question in class because I thought it was too simple and I must be stupid not to know. Thirty years later, while reading a book *All about Waves*, written by a Harvard professor, I saw an answer to the deBroglie wavelength problem—so I calculated the simplest possible wave structure of a particle in three spherical dimensions. I was amazed to find that the waves contained not only the deBroglie basis of QM but also relativity and other natural laws. I could hardly believe my eyes! This was too easy, so I spent another year searching the physics journals to find who had found it before me. There were none! I decided to write my book about the Wave Structure of Matter (WSM). I thought it would immediately be adopted by the science community as the new basis of natural laws. How wrong I was! They fought it tooth and nail, preferring the old discrete particle of the Greeks—with no reasons given. As Machiavelli wrote: *"There is nothing more difficult to plan, more doubtful of success, more dangerous to manage, than the creation of a new system. The innovator has the enmity of all who profit by the preservation of the old system and only lukewarm defenders by those who would gain by the new system."* (Machiavelli, 1513)

I discovered that unless a new concept of science can directly make money, like the transistor or a bigger bomb, almost no one cares about it. As Thomas Kuhn described in *The Basis of Scientific Revolutions* (1980), the paths of history are filled with examples of the science community ignoring important new science for many decades.

HOW DO I ANALYZE PROBLEMS? The following email conversation tells you something about my thinking. A friend of mine asked, "How do you analyze science problems?"

I replied: "I don't mathematically analyze problems in my mind. Instead I search for the 'mechanism' of a problem, trying to see the 3D geometry of it. I am still a 'fix-it' man. To do this my mind unravels the data describing the problem and seeks the physical mechanism which produces it. It is like solving jig saw puzzles or playing the GO game. You search all the patterns and the one that fits suddenly pops into view. It is as the Japanese describe the GO game: "A good player has a sense of '*shape*' for the correct stone placement."

Scientific problems usually involve mathematics that describe physical processes. However math alone is useless. I need to know the physical situations described by the math—and I must visualize the physical or mechanical details of the math process—without that I can rarely use math successfully.

In other words, I use math differently than the way textbooks explain it. I don't go through analysis procedures to find a result, or to prove something. Instead math is just another tool to help fit the pieces of the puzzles together. Puzzles often imbed themselves in my mind and I can't get rid of them until I find solutions. If I find a correct fit, for example the explanation of the

deBroglie Wavelength, only then do I use math to prove it. Proof always comes last.

Most of the physics work I have done successfully was like this. I have worked in space navigation and in planetary physics and I pioneered the mathematics of light polarization. But in fact, I am a poor mathematician. Instead, there is an unconscious search mechanism at work in my mind that I don't control. It finds answers after I worry a lot about problems while trying to sleep. But sometimes I wake up to find my thinking was total nonsense!

NATURE IS SIMPLE. ONLY THEORIES ARE COMPLEX. I cannot forget the history of many complex problems that turned out to have simple solutions. As an example: It was glaringly obvious to me that the models of charge and mass 'substances' of old physics were wrong because there are too many puzzles and paradoxes. When I later read Schrödinger's proposal that substances were properties of the structure of space, I realized the Wave Structure of Matter contained a perfect and very simple description of charge and mass matching his proposal. I genuinely cannot understand why this is not immediately obvious to any scientist. One of the greatest puzzles of physics, is the failure of scientists to become interested in puzzles and want to understand them.

Despite the teachings of the *scientific method*, it appears that most scientists do *not* seek to understand. Instead their personal satisfaction comes from memorizing and following rules that resemble the practice of religion. Most scientists will deny this.

It is tempting to imagine scientists as noble pioneers, questing for the greater good of humanity, and transfixed by the wonderful mysteries of the world. However scientists are not different than other people. A scientist makes choices according to his personal feelings of what is *good* for his own survival. Scientists suffer the same fears, uncertainties, avarice, and hypocrisy as other persons. Few of them are willing to make personal sacrifices in the name of truth. Bread on the table, a car in the garage, and clearing the way for a professorship are usually the first priority in their lives. As Winston Churchill wrote: *"Most of us often encounter the truth but we usually pick ourselves up and pretend it did not happen."*

The old physics is a set of rules and procedures that are obeyed, like a religion, without concern for their origins. In contrast, the Wave Structure of Matter begins with the simplicity of only two principles of waves in one substance—space—from which all else follows mathematically, simply and logically. Philosophically, it is very satisfying. Experimentally, it is true. The rules of old physics produced many paradoxes for the 'church of science' to chew on. Surprisingly the paradoxes became part of the dogma. Is this why the old rules last so long?



Without the broad perspective of my philosopher friend Geoff Haselhurst this book would never have been finished. Not only has he guided my writing and supported me in times of illness, he has contributed the mechanism of motion of particles, the origin of gravity forces, and recognition of the role of philosophers, ancient and modern, who have shaped our present ideas of physics. Because he independently recognized the Wave Structure of Matter, while living in Australia on the other side of *my planet*, you could describe him as my cosmic twin.

I would further like to recognize the hard work of Mike Weber, a mathematician on a nuclear submarine who enthusiastically helped ensure that all my math was correct — although any remaining errors are mine — and whose wonderful programs to show my wave structure in action help to bring my theory to life. Also, Michael Harney, Denys Lepinard, Facundo Bromberg, Karene Howie, and Ray Tomes who have studied the Wave Structure of Matter and have shared their valuable thoughts with me on the Internet.

Finally, I would like to give thanks to my long-suffering wife, Lie Ching Wolff, who has always supported my endeavors, and whose patience and kindness during both sickness and health, during the good and bad, has made all my work possible. Marriage is not easy but we have lasted some 40 years, and I hope it will last many more to come.

I will not forget Professors Tom Gehrels at the University of Arizona and Audouin Dollfus at the Observatoire de Paris who helped so much with the first book.

The new Wave Structure of Matter requires that new words be defined:

TERMINOLOGY

Space: *The space around us is not empty; Space is a quantum wave medium of spherical quantum waves. The energy-density of space is due to the sum of waves from all matter in the Universe.*

Quantum Waves: *The waves in space that form the structure of all matter as resonant in and out-wave pairs. (i.e. electrons, protons, and neutrons).*

Scalar Waves: *The quantum waves in space have a single number amplitude at each point in space and are termed scalar waves. Sound waves are scalar and their amplitude is pressure.*

Spherical in-wave: *A wave converging spherically towards a wave center. It is formed from the combination of the out-waves of all other matter in the Hubble Universe.*

Wave Center: *The center point of converging/diverging in-and-out-waves. The wave center is the apparent location of energy-transfers that appear as a 'particle'.*

Spherical out-wave: *A wave diverging from a wave center. It is a rotational reflection of the in-wave.*

Space Resonance: *A spherical standing wave composed of a superimposed in-wave and an out-wave. This wave is the basic structure of electrons and charged particles.*

Spin: *The result of an in-wave rotating at the center to become an out-wave. The rotation is 720° and the spin produced is $\pm \hbar/4\pi$. It can only occur in 3D space.*

Energy: *The substance of space. Observable only when energy transfers occur.*

Energy Transfer: *This occurs if both source and receiver wave-state are resonant; i.e. have the same frequency.*

Space energy-density: *The energy-density of Space is equal to the sum (squared) of wave amplitudes from all the resonances in the (Hubble) Universe.*

Universe: *Consists of all the matter we can observe contained within a Hubble sphere. It is a finite spherical Universe within an infinite space.*

Hubble Universe: *The size of the Universe obtained by Edwin Hubble by star and galaxy measurements.*

Velocity of Light (c): *The velocity of quantum waves in space is about 3×10^8 meters/second. c depends upon the elasticity and density of space.*

Time measure: *The basic 'clock' of the Universe is the frequency of waves. Time depends on the elasticity and energy density of space. It varies very little in the Universe because matter is spread widely.*

GLOSSARY TERMINOLOGY FOR WAVE STRUCTURE OF MATTER



Length measure: *The basic 'ruler' of the Universe is the wavelength of space waves. It depends on the elasticity and energy density of space. It varies very little in the Universe because matter is spread widely.*

Principle I of the WSM: *"Space is a medium of quantum waves that obey a scalar wave equation."*

Principle II of the WSM: *(The Space density Principle). "The energy-density of space is the sum (squared) of wave amplitudes from all matter in the Universe."*

Minimum Amplitude Principle (MAP): *"Waves at each point of space minimize their total combined amplitudes."*

Matter Waves: *The scalar quantum waves of an electron, proton or neutron.*

Electromagnetic waves: *These cannot occur in free space, only in metal wave guides; because they are vector waves that require four quantities to describe wave amplitude and direction.*

PIONEERS OF THE WAVE STRUCTURE OF MATTER

William Clifford (1845-1879): *An English Mathematician-astronomer at Cambridge University. He first proposed (1850) that "All matter is undulations in the fabric of space."*

Erwin Schrödinger (1887-1961): *Austrian physicist (later American). Discoverer (1924) of the Schrödinger Equation describing waves of an electron. He proposed, "All matter and laws are the appearances of quantum waves in space."*

Albert Einstein (1879-1955): *German physicist (later American) known for his Relativity theories in 1905 and 1915. He agreed with Schrödinger that discrete particles are impossible but had to be extended in space.*

Paul A. M. Dirac (1902-1984): *An English Mathematician-physicist at Cambridge University. He first used in-waves and out-waves as solutions of the Schrödinger Equation and found the Dirac Equation describing spin $\pm \hbar/4\pi$, of the electron-positron.*

Milo Wolff (1923-): *An American physicist-astronomer who first found the Wave Structure of Matter and the Principles of space. Published in Exploring the Physics of the Unknown Universe (1990).*

Geoff Haselhurst (1960-): *An Australian Philosopher who tracked the history of the origin of the WSM. He first discovered (2001) the origin of gravity; that massive bodies change the motion of in-waves.*

CHAPTER

ONE

INTRODUCTION TO THE WAVE STRUCTURE OF MATTER

- I. What is the Structure of Matter?
- II. Waves. There are no particles in this book.
- III. Solving Enigmas with a Wave Structure of Matter.

"At every crossroad on the way that leads to the future, each progressive spirit is opposed by a thousand men appointed to guard the past."

– Count Maeterlinck, 1911 Nobel Prize Laureate (Literature)



SECTION I WHAT IS THE STRUCTURE OF MATTER?

The goal of this book is to describe a recent answer to this very ancient question. The answer has immense practical consequences for science, physics, chemistry, medicine, and technology; and, if you enjoy philosophy, you will find breath-taking conclusions about the connections of life to the Universe. The answer to this goal turns out to be quite simple. In fact, it only requires changing our perspective of a particle. We have to make a mental change of the particle from a discrete material object like a grain of sand to a wave structure in space. The physics and math involved are very simple. The real complexity is how to change the older particle ideas embedded in our minds by the culture and history of science over thousands of years.

Many people, from the Greek philosophers such as Democritus and Pythagoras, up to the colleagues of Albert Einstein, sought to understand the structure of the tiny atoms and molecules in our everyday world. Until recently, most ideas have been speculations in analogy to objects around us: like baseballs and bullets, and grains of sand. Electrons were imagined to move like familiar objects such as moons around planets and toy tops spinning on a table.

Serious thinkers, such as Einstein, Schrödinger, and Ernst Mach, realized that these analogies were wrong. Instead, experimental measurements showed that the structure of matter was closely related to the properties of the apparently empty *space* around us, and that the elements of matter had to be spherical and extended in space. The best thinkers, especially Clifford and Schrödinger, clearly proposed that matter was a wave structure in space. Their conclusions in hindsight were prophetic. Einstein rejected the discrete point particle and stated that matter must be spherical entities extended in space. They arrived at their conclusions by painstaking analysis and careful adherence to the rules of logic, and the philosophy of truth. But their words fell on deaf ears.

THE WAVE STRUCTURE OF MATTER (WSM)

Described in this book is a wave structure propagated in a space medium (figure 1.1). This structure not only satisfies experimental observation but also displays a simple but beautiful tapestry of the physical universe that inter-connects matter, the cosmos and ourselves.

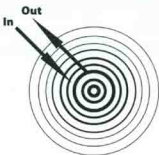


Figure 1.1: The wave structure that creates a resonance in space—an electron.

**A Space Resonance
Has Spherical Symmetry**

The application of this *Spherical Standing Wave Structure of Matter* (WSM) reaches out, on the one hand, to unsuspected fields of cosmology such as the Big-Bang, the red shift, and the structure of the universe. On the practical side, a new tool is provided that will enable us to deeply understand and improve industrial devices such as nanotechnology, computers, micro circuits, bio-molecules and the efficient transmission of electric energy.

The discovery of physical reality is a remarkable claim that has been a holy grail of intellectual thought for thousands of years. Nonetheless, we are convinced that for the first time in human history, we have an accurate description with the *Spherical Standing Wave Structure of Matter* and hope that this book will help you understand the theory. We hope that readers will gain information and perspective so that they can confirm for themselves that this description of reality deduces the observed laws of nature.

To accomplish this task it is necessary to provide scientific logic. This does not mean that this book is written only for scientists. On the contrary, logical truth simplifies and provides perspective. In short, this book is for everybody who is curious about the natural world around us.

Because the truth has remained hidden for so long, many people quite reasonably, could assume that this subject is too complex and difficult for them to understand. No. This is not the case. The wave structure of matter has an underlying simplicity that makes it easy to understand. The story of its discovery becomes an adventure in history. It is also an exciting story of how scientific truth is affected by the frailties of human emotions, economic ambition, and the power of politics.

Parts of this book contain direct quotes from Erwin Schrödinger, Albert Einstein and other philosophers of science. These men had already developed valid basic theories and thus had an enormous knowledge of Nature. Erwin Schrödinger, one of the founders of quantum theory, knew intuitively the nature of the quantum universe. One of their uncompleted goals was to find a connection between quantum theory and the role of *space*. Their ideas needed only logical extension and math additions, to produce the Wave Structure of Matter. You will be amazed at the simple result they almost had in their grasp.

AT FIRST, YOU WON'T BELIEVE IT!

What happens when a new aspect of the physical world is discovered? At first sight it is difficult to believe, say like Copernicus' solar system, or the quantum theory in 1920. Similarly, scientists today have to change their minds about matter but it isn't easy. Below are two stories that illustrate this difficulty:

1) The Fifth Inter-Galaxy Survey Command.

Imagine you are the commander of the fifth inter-galaxy survey unit and your field captain is speaking to you: "They're made out of meat."

"Meat?"

"Yes, meat. They're made out of meat."

"You mean, meat?"

"There's no doubt about it. We picked several from different parts of the planet, took them aboard our recon vessels, probed them all the way through. They're completely meat."

"That's impossible. What about the radio signals? The messages to the stars?"

"They use radio waves to talk, but the signals don't come from them. The signals come from machines."

"So who made the machines? That's whom we want to contact."

"They made the machines. That's what I'm trying to tell you. Meat made the machines."

"That's ridiculous. How can meat make a machine? You're asking me to believe in sentient meat."

"I'm not asking you, I'm telling you. These creatures are the only sentient race in the sector and they're made out of meat."

"Maybe they're like the Orfolei. You know, a carbon-based intelligence that goes through a meat stage."

"Nope. They're born meat and they die meat. We studied them for several of their life spans, which didn't take too long."

"Okay, maybe they're only part meat. You know, like the Weddilei. A meat head with an electron plasma brain inside."

"Nope. We thought of that, since they do have meatheads. But I told you, we probed them. They're meat all the way through."

"No brain?"

"Oh, there is a brain all right. It's just that the brain is made out of meat!"

"So... what does the thinking?"

"You're not understanding, are you? The brain does the thinking. The meat."

"Thinking meat! You're asking me to believe in thinking meat!"

"Yes, thinking meat! Conscious meat! Loving meat. Dreaming meat. The meat is the whole deal! Are you getting the picture?"

"Oh my God. You're serious then. They're made out of meat."

"Finally. Yes. They are indeed made of meat. And they've been trying to get in touch with us for almost a hundred of their years."

"So what does the meat have in mind?"

"First it wants to talk to us. Then I imagine it wants to explore the universe, contact other sentients, and swap ideas and information. The usual."

"They actually do talk, then. They use words, ideas, concepts?"

"Oh, yes. Except they do it with meat."

"I thought you just told me they used radio."

"They do. They use radio to talk by flapping their meat at each other. They can sing by squirting air through their meat."

"Oh my God. Singing meat. This is altogether too much. So what do you advise?"

"Officially, we are required to contact, welcome, and log in all sentient races or multi-beings in the quadrant, without prejudice or favor. Unofficially, I advise that we erase the records and forget it."

"I was hoping you would say that. I agree one hundred percent."

"But will this work? How many planets are we dealing with here?"

"Just one. They can travel to other planets in special meat containers, but they can't live on them. And being meat, they only travel through C-space. Which limits them to the speed of light and makes the possibility of their ever making contact pretty slim. Infinitesimal, in fact."

"So we just pretend there's no one home in their universe."

"That's it."

"Good. Agreed, officially and unofficially. Case closed. Any other kind in the galaxy?"

"Yes, a rather shy, hydrogen-core cluster intelligence in a class nine star in G445 zone. Was in contact two galactic rotations ago, wants to be friendly again."

"They always do."

"And why not? Imagine how unbearably, how unutterably cold the universe would be if one were all alone."

2) Where are the Bicycles in New York? This is a true story. In the 1950's I was one of the first American science professors in Indonesia, and during an informal discussion with a group of students, one asked:

"Prof... as a sophisticated university student I read a lot about the United States and I enjoy watching American films but there is one thing that puzzles me. When the films are being made, how do the police completely remove all of the bicycles from New York City?"

Now, at that time, in Indonesia, bicycles were everywhere. Few persons could afford a motor-bicycle—much less a car. I realized there was a lot of explaining to do. So I did my best to explain how the economics of a large city made buses, subways, and taxis the best choice for transportation and that there were *no* bicycles in New York. They were incredulous! They did not believe me.

Another student objected, *"What about the farmers who come to the city? They need bicycles."* *"What about the longshoremen? (Coolies with bicycles, in their view). How can they buy cars? And if they did get one, why don't the police steal it from them?"*



The reader can guess how I tried to explain such questions but it soon became clear that the students thought I was bragging about the wealth of the USA and made up my answers to fit.

Finally one student decided to put me in my place. "*Prof... I had a friend who made a visit to Boston and Harvard University. Now, isn't it true that Harvard is the richest university in the world?*" I agreed. "*Well prof, my friend told me that all of the students at Harvard rode bicycles!*" What could I reply? Truth is usually no match for emotion and belief.

THE PERCEPTIVE THOUGHT OF ERNST MACH.

Have you ever watched the sky at night and wondered about the thousands of twinkling stars above? At first they appear to be only beautiful decorations of the heavens. But if you think about their total mass, as the astronomers calculate it, it is 10,000,000,000,000,000,000,000 times larger than our own solar system mass. Knowing this, your thoughts may be different! Surely such an enormous mass—even though far away—must have an affect on us on the Earth. Are we, and the Natural Laws we experience on Earth, separate from the rest of the huge Universe? Or are we connected together?

Astronomer Ernst Mach, a close associate of Albert Einstein, thought so. He wrote, about 1890, "*The law of inertia is determined by the presence of the fixed stars.*" He was referring to the law of centrifugal inertia that we experience every time we spin on a piano stool or drive a car around a curve. Einstein agreed with him and incorporated it into General Relativity (GTR). It is similarly incorporated into this book. In fact, both GTR and the WSM are identical except that GTR describes the Universe using complex math beginning on an astronomical scale and the WSM describes the Universe with simple math beginning on an atomic scale.

We will see that the matter of the Universe similarly determines not only the law of inertia, but also all the other natural laws. They are properties of the *space* around us that accordingly determines the entire Universe. This remarkable fact that all the laws and rules of physics, chemistry, biology and life are determined by all the mass of the Universe can be expressed by stating, "*We are part of the Universe and the Universe is part of us.*" Everything is joined together as an inseparable universal whole. Accordingly, it is impossible that we could exist alone on the Earth without the rest of the Universe.

Much earlier, the famous geometer-mathematician William Clifford [1870] proposed that: *All physical laws are the result of undulations (waves) in the fabric of space.* And later (1950) Erwin Schrödinger, founder of quantum theory, wrote, "*What we observe as material bodies and forces are nothing but shapes and variations in the structure of space...*"

Yet the science community today has ignored Mach's unusual observation of the stars and *space* even though it stops being mysterious as soon as you think about it. They have ignored it because it cannot be

understood using the particle model of matter that is embedded in the science community. It is explained simply in this book, using the Wave Structure of Matter in the *space* of the Universe.

I want to convince you that particles are really structured of waves; not mass or charge substances, just waves alone. Some readers may have preconceptions of discrete particles, like bicycles in New York or sentient meat on Earth! But I hope most of you will have an open mind. There are no particles; just waves whose appearance from a human-scale look like particles.

HISTORICAL CHANGES OF THE FOUNDATIONS OF SCIENCE.

If we view the concepts of science through thousand of years of history, we see a remarkable parallel between human's perceived physical environment and their scientific perspective. It is as though scientific vision was limited by geographic vision. For example, when the largest social units were towns and villages, natural laws were thought to be controlled by gods of the forest, the earth, the sea and the sky. When astrologers—working for kings and the church—studied the relative motion of the Sun, Moon and Earth, God and his angels determined the rules of science, with the Earth as the center of motion.

After Galileo, Kepler and Newton calculated and observed the true relative motion of the Sun, Earth and planetary moons, the scientific horizon of physical law expanded outward to encompass the Solar system. But the authorities of the scientific community do not change their perspective easily. This is seen in a letter by Galileo:

"I wish, my dear Kepler, that we could have a good laugh together at the extraordinary stupidity of the mob. What do you think of the foremost philosophers of this University? In spite of my oft-repeated efforts and invitations, they have refused, with the obstinacy of a gluttoned adder, to look at the planets or Moon or my telescope."

Galileo was placed under house arrest for several years because of his divergent views. A fascinating book written by and titled *Galileo's Daughter* describes their relationship and life at that time.

After studying the properties of matter at atomic dimensions much smaller than our human realm, scientists like Benjamin Franklin, Faraday, Lorentz, Coulomb, and Maxwell extended their physical environment to atomic dimensions. Accordingly, the concepts of "particles", "electrons", "protons" etc. all were created—although no such particles had actually been identified.

When powerful telescopes discovered the existence of our Galaxy, the laws of physics were modified to include galactic motion because scientists believed that our galaxy was the entire universe. After Edwin Hubble discovered large numbers of galaxies apparently with outward motion, scientists calculated that

SECTION II WAVES: THERE ARE NO PARTICLES IN THIS BOOK

the enormous Universe consisted of about 10^{22} galaxies but —perhaps because these other galaxies are so distant— scientists continued to believe that the laws of the Universe were properties of only the ‘particles’ found here on Earth, un-related to the existence of the enormous amounts of matter elsewhere in the Universe.

Ernst Mach (1890) and later Einstein (1915) observed that the law of inertia, ($F = ma$) first found by Newton, depended upon the existence of the matter of the entire Universe. Nevertheless, this is generally misunderstood and ignored today with myopic vision because scientific laboratories are located on the Earth. For example, if you proposed that all of the natural laws depended on the matter of the entire Universe, you would be seen as crazy. Yet this is true. Think for a moment: the mass in the Universe is a *thousand billion billion* times that of our galaxy, and our galaxy mass is another *thousand million billion billion* times that of our Earth. Is it reasonable or logical to assume that the laws of Nature and the Universe are unique to Earth? The book will show that we on the Earth are a part of the entire Universe which is an inseparable whole; *If the stars did not exist, we could not exist.*

The first perception of the matter of the Universe was proposed by William Clifford [1870] at the Cambridge Philosophical Society, saying: *All matter is simply undulations in the fabric of space.* He envisioned that the entire space of the Universe was one wave medium and that matter is a wave structure in that space. He derived mathematics that predicted Relativity and Quantum theory that were still 50 years in the future. People listened but neither believed nor understood him. Later, Erwin Schrödinger similarly proposed (1937) “*What we observe as material bodies and forces are nothing but shapes and variations in the structure of space. Particles are just schaumkommen.*” Together, he and Einstein opposed the particle theorists led by Neils Bohr. Most scientists today believe that Einstein and Schrödinger lost those debates. It is a major purpose of this book to show that they were *right*; all matter and particles are a Wave Structure in the space of the Universe and that the origin of all the natural laws are a result of these structures, and that; *If the stars did not exist, we could not exist.*

THE WAVE STRUCTURE OF MATTER (WSM).

The central theme of this book is that matter is not particles like microscopic sand, but instead are spherical quantum wave structures in the *space* around us; see Figure 1.1. The WSM replaces the former assumption that matter is discrete material particles (a view held by most science philosophers for thousand of years). Their assumption was not the result of logic or laboratory investigation but rather a guess—the result of ignorance of things too small to observe. For example, *Democritus* described matter as *atomos*: a Greek word for undivided small things. Benjamin Franklin similarly guessed that “charge” was a fluid that could flow from place to place. These ideas were perpetuated for centuries in textbooks without critical examination and became accepted.

THE NEW PERSPECTIVE OF SPACE AND THE WSM.

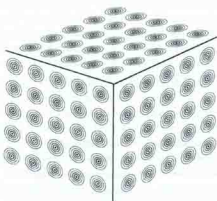
This book shows new consequences of the WSM that are breath-taking if you are first learning about space and its wave structure. You will find that:

- 1) Nature is very simple indeed: everything is a mathematical result of just two WSM Principles that describe the properties of the quantum space around us.
- 2) The origins of the natural laws, formerly obtained empirically, are a result of space and the Wave Structure of Matter.
- 3) There are many new applications of the WSM ranging from building tiny microchips to understanding the vast cosmos of the Universe.
- 4) The many enigmas (below) that have puzzled believers of the old particle notion for a century or more are now simply understood by those who learn and know the WSM:

ENIGMA 1-1:

WHY DOES A DIAMOND APPEAR HARD AND SMOOTH?

A diamond stone with apparent smooth facets is really a collection of quantum wave-centers held together in a lattice by the quantum rules for waves. Each wave-center (carbon) is comprised of six neutron, six proton, and six electron wave-centers. These 18 centers are held by the quantum rules in a unique three-dimensional lattice of Figure 1-2. In the quantum realm, the lattice is not smooth at all!



Structure of a Crystal

SECTION III SOLVING ENIGMAS WITH A WAVE STRUCTURE OF MATTER



Figure 1.2: The wave structure of a crystal. The individual waves of the atoms of a crystal join together to form a lattice that chooses minimum total wave amplitude of the entire crystal structure. This wave behavior is similar to the idea that "Water seeks the lowest level." The reason for the hardness of the crystal is that displacing the waves requires an energy input; force is the rate of change of energy.

But our human senses are unable to observe single atoms or even single molecules. What we imagine to be particles are always collections of quantum wave centers. If we want to be accurate and logical (necessary for the science game) it is important to deduce that we humans often think we see particles but never do. When we measure objects in the human realm, we are actually measuring large groups of atoms or molecules or wave-centers like a diamond. The human observations are the averages of many tiny objects, which follow quantum rules. It is only to our human perception that the appearance seems smooth.

THE PUZZLES OF LENGTH, TIME AND MASS.

Most of science is obtained by measuring the world around us. In our complicated lives we measure all sorts of things; for example: bank accounts (in dollars), tire sizes (inches of diameter), speed (meters per second), our weight (kilograms), paint colors (frequency of light), etc. It has long been realized in science that all of these different measures can be reduced to just three basic units (A fourth is needed if you include electric charge). Many choices for the basic three are possible, but the usual choices are length, time and mass. All the rest are combinations of these three. Since this book is about basic origins of Nature, it is very important to understand the origin of these three basic units. What determines them? Before the WSM no one knew.



ENIGMA 1-2: WHAT IS LENGTH?

Engineers who want accurate measurements take them from standard bars of platinum that have fine lines inscribed on them. There is a standard meter-bar kept in Sevre, near Paris. Copies are kept in major laboratories of the world. Another standard is a light wavelength from krypton gas, used as a length, by reflecting the light back and forth between mirrors. The mirror separation is then an exact multiple of the wavelength.

These Earthly definitions of length are quite clear—but what determines length everywhere in the Universe? Suppose we magnify the meter bar until we are observing the platinum atoms held together in their lattice. Now we notice that nothing is very solid anymore. We can count the number of atoms between the two fine lines, but there is a great deal more empty space than atoms between them. So, what determines the standard length? Is it the space between atoms? How does the space 'know' its length?

Using the old notion of discrete particles this question is unanswerable. But the WSM shows you that the universal length is the wavelength of the electron structure that is everywhere in the *space* of the Universe. More is explained later in Chapters 3, 4 and 14.



ENIGMA 1-3: WHAT DETERMINES TIME?

Recently, no one understood how the same time periods appeared everywhere throughout the Universe. To determine time on the Earth we use the rota-

tion of the Earth. We measure the beginning and end of a revolution when the position of a fixed star (not a planet) passes the cross hairs of a rigidly mounted telescope.

The light, which travels from the stars, goes through empty space. It is almost the same result as before, except now the result seems to involve the position of the stars, as well as the empty space. Why? What could the stars have to do with time?

In the WSM, the unit of time is the period of one oscillation of the electron space resonance. This period depends solely on the density of space. Thus time everywhere in the Universe depends on *space*. Space determines time just as it does the measure of length. Later we will see that the density of space is determined by quantum waves from all the matter of the Universe. Accordingly, all matter is inter-connected!

ENIGMA 1-4: WHAT IS MASS?

Until the WSM, no one knew the origin of natural laws that involve mass. The third fundamental unit, mass, m is related to energy E , and frequency, f of energy exchanges. Ever since Einstein found that $E=mc^2$, and Planck showed, $E=hf$, comparisons of those measurements have verified their equality. In other words: $E=mc^2=hf$. We can accept this equality as a fact of nature. Either mass or frequency or energy can be used as the basic unit, since they are equivalent to each other except for the multiplier constants c^2 or h . Our task now is to attempt to understand the enigma of what these units are.

Mass (m), can be measured in two different ways which appear not to be connected with each other. Yet it always turns out that both masses are the same. The first way is the force of *gravity*, discovered by Newton: $F = G (m_1 \times m_2) / R^2$ where G is a constant, R is the distance between two objects, of mass m_1 and m_2 . In this method, an unknown mass m_1 is measured by comparing with a known standard mass m_2 . Both masses are attracted by the Earth's gravity. This kind of mass is called *gravitational mass*. We know how to calculate it but we don't know how it works, its origin or its connection with other forces. It is just there.

The second method of finding mass uses a rule discovered by Galileo and Newton: $F = ma$, where F is the force (say, from your arm muscle) needed to speed up with an acceleration (a) the mass (m) of a rock you are throwing across a river. This kind of mass is called *inertial mass* because the resistance to change of speed is what we mean by the word inertia. Just like gravity, using the old particle notion of matter, no one knew anything of the origin of Newton's inertial law, although we can calculate it perfectly.

ENIGMA 1-5:

WHY ARE INERTIAL AND GRAVITATIONAL MASS IDENTICAL?

Why do these two independent ways of measuring mass give the same result? The measured equality of the two kinds of mass has been verified for all materials made of different combinations of electrons, protons and neutrons.



There is not yet any measurement of gravitation for anti-protons or positrons because gravity is too weak to measure single particles and we know of no way to combine them into solid materials. Unfortunately, measurement is insufficient to tell us why they are alike. Scientists would like to know why. The WSM opens our eyes and we discover that change of the frequency (mass) of the waves is identical for both ways of measuring mass. This is explained in Chapter 14.



ENIGMA 1-6: WHAT IS THE CAUSE OF INERTIAL FORCES?

Ernst Mach in 1890 drew his famous conclusion termed "Mach's Principle". He wrote, "*The law of inertia depends on the presence of the fixed stars.*" This was because he noticed that rotational motion produces radial force (inertia) only if the motion is with respect to the position of the fixed stars (try it yourself). In other words, the stars appear to determine a frame of reference for rotational motion. One can also surmise that linear motion (the rock you throw across the river) uses the stars as the frame of reference for acceleration. One reason Mach's Principle had not been recognized was because people asked, "*How can the motion of an object on Earth be communicated to the stars and back again in an instant? Impossible!*" Also, some scientists were not curious and did not care to understand. It was enough to calculate $F = ma$.

The WSM provides an amazingly simple origin of Mach's Principle: it is the presence of the unseen *space* (quantum-wave medium) around us and throughout the Universe that becomes the frame of reference for acceleration. The density of this space is determined by waves from all the objects (stars, galaxies and other mass) in the Universe. So we see that Mach was really observing the presence of the quantum *space* around us, rather than the stars that produce it. There is no need to travel to the stars.

Principle II of the WSM uses a math version of Mach's Principle to calculate the quantum *space*; it agrees with the General Relativity Theory (GTR) and displays the Natural Laws. It is important to realize that the quantum space is the heart of the Universe. It is the *one thing* that unites all of the Natural Laws, astronomy, cosmology—and our lives that are inter-connected with them. This is explained in Chapters 4 and 13.

All that you need in order to learn the WSM and know the complete origin of the laws of the Universe is to understand the existence of quantum-space and its two properties: Principle I and Principle II. Nothing else.



ENIGMA 1-7: WHAT IS GRAVITY?

Before the WSM, no one knew the origin or the cause of gravity despite the fact that millions of dollars have been spent searching, and dozens of proposals litter the pathways of science. Newton named the gravity enigma: *action-at-a-distance* and also wrote, *Anyone who believes that energy can travel instantly to the*

planets is a fool. Nevertheless, astronomers today calculate planetary motion as if gravity forces did travel instantly – only because it gives the right answers!

The answer using the WSM is so simple that at first you will think it too easy! The significant clue is the presence of the quantum-space in the Universe. The density of quantum-space is almost uniform (thus velocity of light is almost constant) everywhere because the number of bodies in the Universe that contribute to space density is so large. But near a massive body like the Sun, the additional waves of the Sun slightly increase the density around it. As a result, the inward spherical waves coming to another nearby body travel slightly faster causing their wave-centers to move towards the Sun. We interpret this motion as due to the force of gravity. Now you know. That's it! The math of gravity is in Chapter 15.

ENIGMA 1-8: WHAT IS A PHOTON?

When an energy exchange occurs between, say, two molecules one wonders what is traveling between them. If we don't know, we say it is a "photon." Giving it a name doesn't add any knowledge, but it allows us to feel better and we can pretend we know what travels. Einstein received a Nobel Prize in 1905 for discovering the photon and the photoelectric effect. But later he realized he did not know what a photon was. He wrote (1954) to his friend Michael Besso:

"All these fifty years of conscious brooding have brought me no nearer to the answer to the question, 'What are light quanta?' Nowadays every Tom, Dick and Harry thinks he knows it, but he is mistaken..."

The WSM provides the easy answer: energy exchange is due to wave resonance between the source and receiver atoms or molecules. This is a common situation between instruments in an orchestra or reception of radio signals. But Einstein lived when the WSM did not yet exist.

THE PROBLEM OF SEEING NATURE IS IN OUR MIND.

When observing Nature we need to ask: *How do our minds process data?*

In particular, what is our mental mechanism that changes wave structures into images of the objects we see in our large-scale human perspective? For example: When we see a cubic array of waves, why do we think of it as a crystal of salt? Why do we think that the 'apparent' edge of the array is 'solid'? Or in astronomy, when the density of the wave medium is increased around a Sun causing the wave paths to bend, why do we interpret this as a 'force of gravity'?

It should be obvious, after thinking a while, that most mental processes are due to:

- 1) The way our human sensory apparatus and brain operate for our survival.
- 2) The enormous difference of size of the waves (atomic) and ourselves.
- 3) The emotional blunder of 3,000 years of history imagining that matter was made of discrete particles, like Greek beach sand!



This blunder has affected science in many ways. Einstein argued against discrete particles, but particle physicists paid no attention to him. Their attention was focused on the government that was granting large sums of money for 'particle' accelerators, hoping for new weapons. *He who pays the piper calls the tune.* Emotions play a powerful (often hidden) role in the motivation for scientific research. Mainstream science has comprehended the universe in terms of our own local experiences. But only a few people like Einstein saw that grains were impossible. He asked how the grains communicate forces—unexplained by the old standard science. Formerly, and still today, forces were accepted as faith in Nature without much thought.

MICRO VS. MACRO.

What is the difference in perspective of *atomic* structures vs. *macro* particles? The answer is actually simple. For example: from a distance the Moon appears perfectly round and smooth, yet close-up it is covered with rugged mountains. The skin of a pretty girl's face appears like satin but through a powerful microscope it is pocked with pores and has thousands of micro-bugs crawling there. Think of a snowstorm or a mirror. You know the answers. Similarly, we know that "particles" are wave structures at the atomic-quantum-wave level.

Charge and mass substances do not exist but are one of the appearances of the structures. The energy of the electron's in-out spherical waves is concentrated at the center within a radius of about 10^{-15} meter but its amplitude extends out to infinity. How do we describe this close up? A 10^{-15} dense wave structure of course. How does this appear to our macro lab instruments? A point particle, of course!

Suppose you put a billion, billion of these wave centers together using carbon-12 atoms. What happens? All the electron waves arrange themselves in such a way as to produce *Minimum Amplitude* of the total waves. This becomes a lattice of waves. What does this lattice look like from the macro human level? A solid diamond crystal!

Why don't we observe the diamond as a bunch of waves? Because the energy density of the crystal waves is enormous. If we poke them with a needle, the resisting force to move even 10^{-14} m is more than enough to break the needle. Our minds interpret this behavior as a solid. But it is really only a bunch of waves in a lattice!

UNDERSTANDING OUR MINDS—SURVIVAL. The basic problem here is not any mysterious property of quantum theory or magical matter. The difficulty lies in how our minds work. Our genetic heritage forms our minds to enable us to survive in an antagonistic world of competing organisms. We need to find food, capture mates, propagate the race, fight off enemies, etc. Our genes couldn't care less about particles, waves, wave properties, or the wave medium in space. As a result, we have no sensory gadgets in our mind or body to directly detect matter waves. The way for us to find and learn them

is to experiment and logically deduce the truth of the reality of matter using our mental abilities.

Sitting in an armchair and speculating upon planetary motion won't get you very far at the quantum level of matter. Nor will the habit of memorizing the old rules of particle matter. You need to study and think how waves can produce the appearances of Nature that we observe. Don't feel bad that you haven't done this yet. For three thousand years most scientists made and repeated the same blunder—that matter is made of discrete particles. Einstein and Schrödinger said they were wrong but no one paid attention. Now you can find the answers in this book and on the web. Notice that there are many old wrong ideas about matter and energy. You will have to identify them and un-learn them—ruthlessly! This is the tough job.

Einstein thought that true scientists were rare. He wrote to Robert A. Thornton, 7 December 1944: *I fully agree with you about the significance and educational value of methodology as well as history and philosophy of science. So many people today—and even professional scientists—seem to me like somebody who has seen thousands of trees but has never seen a forest. Knowledge of the historic and philosophical background gives that kind of independence from prejudices of his generation from which most scientists are suffering. This independence created by philosophical insight is—in my opinion—the mark of distinction between a mere artisan or specialist and a real seeker after truth.* Einstein is right, we can all become better scientists by adopting independent thinking habits.

Later in this book. The following chapters will expand on: the Wave Structure of Matter, the origin of the Natural Laws, and understanding the fascinating former puzzles of Nature described in the Enigma's above.



CHAPTER

TWO

QUANTUM WAVES, NATURE, MATTER AND SPACE

- I. Science, Nature and the Universe.
- II. Principles of the Wave Structure of Matter.
- III. The Search for Truth and Reality.
- IV. Introduction to the Following Chapters.

*"A fish probably has no means of comprehending
the existence of water; it is too deeply immersed in it."*

– Sir Oliver Lodge



This book is an adventure unraveling the exciting mystery of quantum waves, matter and space and how people think about them. *Quantum* was once considered a strange phenomenon usually only seen on the blackboards of a physics lecture. For about sixty years, it was practiced as a theory steeped in the equations of physics. Only those intrepid students who could gulp down whole differential equations for breakfast dared to seek its meanings. As late as 1963, the highly respected guru of theoretical physics Richard Feynman wrote, *"If you feel confused by quantum theory, don't worry. Nobody understands quantum theory!"*

In this book, I will unravel the mystery of quantum by presenting a theory of the structure of matter particles that also includes the structure of the universe. For 3,000 years, scientists and layman alike had thought that the fundamental building block of matter was something akin to a very tiny grain of sand, often termed a point particle. However, empirical measurements do not bear out this perception—hence the development of quantum wave-theory. There have been many attempts to marry quantum theory with discrete point particle behavior, and many strange dimensions of space and strange types of particles have been the result. Now in this book there is only one quantum-wave structure of matter that easily explains both.

It is the main purpose of this book to replace the old discrete particle of matter with a new Wave Structure of Matter (WSM). You will not have to understand quantum theory to understand the simple structure of everyday particles made of quantum waves. Nature's laws are simple, rather than complicated. The WSM is a simple structure that contains within it the formerly complex quantum theory. The new theory is simple and obvious; the fundamental particle is made solely of waves, whose appearance mimics a point particle. This theory has the benefit of agreement with empirical evidence.

Now, everyone can discuss quantum waves at breakfast without disturbing their digestion. For sixty years, we have been blinded to the quantum structure of the universe that is all around us, or more correctly, we are part of. In fact, all the matter of our bodies, of the room we are in, the air we breathe, are structured of quantum waves. It has been so near to us that we could not see it. As the philosopher, Sir Oliver Lodge wrote, *"A fish probably has no means of comprehending the existence of water; it is too deeply immersed in it."* We have not recognized the quantum waves of the universe because we are too deeply immersed in them.

This book is written for everyone interested in science: everyday philosophers who have always been curious about the world around them; those people who find joy in logical thinking and its rewards; those people who want to know what is out there beyond the clouds, the sky, and the stars; the person who seeks to understand the paradoxes of nature, such as the behavior of light, that is familiar to everyone yet was formerly understood by almost no one. In short: all curious, thinking people.

But there is also a dark side to the growth of science. It is tempting to imagine scientists as noble pioneers, questing for the greater good of humanity, and transfixed by the wonderful mysteries of the world. However

SECTION I SCIENCE, NATURE AND THE UNIVERSE

scientists are no different than you or I. All the deadly sins of mankind (and womankind) are also found in the hearts of scientists. Recognizing this will help you to understand why the growth of science sometimes behaves in strange ways. And why progress often requires centuries to dispel adored traditional scientific illusions.

THE SIMPLE UNIVERSE AND NATURAL LAWS.

For several centuries engineers and scientists have noticed that Nature seems to have chosen simple rules to guide the behavior of matter. These rules have been measured and are called the natural laws—about a half dozen, plus another half dozen associated constant numbers. In the search to find other rules and learn how nature does it, scientists often propose very complicated theories described by even more complicated mathematics. But inevitably, when the chips are all down on the table and the answers appear, the simple rules win and the complex theories go into the trash bin.

TWO SIMPLE PRINCIPLES GOVERN THE UNIVERSE. We, the authors of this book, are happy to tell you the reader, about two very simple principles that underlie the structure of matter and of the universe, which we call Principle I and Principle II, described later in this book. Because of their simplicity they are also far-reaching and encompassing. The old measured natural laws are largely unchanged; the new discovery is that now you know where they come from and this knowledge opens a new window onto the Universe. After reading this book, you will enjoy an amazing sense of intellectual power. You will know that you have grasped universal concepts of nature. Instead of just following rules to calculate behavior, you will understand how the rules operate and why things happen as they do. You will see that the universe is an inter-connected whole; each part depends on every other part. Thus, the universe is part of us and we are part of the universe. This is what this book is about.

MATHEMATICS IN NATURE. It has been found through the centuries that Nature is always consistent; that is, her rules can usually be described by mathematical equations. In the past, most of the equations or laws of nature did not tell us how Nature carries out her activities; they only told us how to calculate the results. Consequently the science of physics has become more and more authoritarian emphasizing precise calculation and obedience to the rules and those who teach them, rather than depth of understanding. In the future this will change, and you, a first reader of this new book, may be one of the contributors to changes that bring about a better philosophical understanding of Nature and the Universe.

Nature's equations are very useful to engineers and scientists who need them to make machines and computers, and to provide electrical power that drives them, but equations are not necessary to understand and apply the two basic principles of Nature's universe. This is because the basic principles are very simple concepts; the new equations are merely a quantitative elaboration of easily understood concepts. Accordingly, we will not burden these



pages with excess mathematics. Instead, in those cases where some professional engineers and scientists could enjoy them, the equations will be available in the last chapters.

NATURE, SCIENCE AND PHILOSOPHY. The simplicity of Nature seen when we truly understand the Quantum Realm brings an amazing vision of the universe and our role in it. We will discover that the evolution of life and our natural environment and human society are inter-connected with each particle of matter in the universe. Let's start by looking at the history of the Quantum Realm:

Around the years 1910–1920, laboratories that investigated the micro-structure of matter began to notice that the behavior of nature seemed to be involved with waves. This was regarded as unusual because for three millenia, scientists had convinced themselves that the elementary structures of matter were “particles”. In order to explain and describe these new wave findings, new theories and equations were proposed. This was called quantum theory (see Schrödinger, Dirac and Feynman). Quantum theory provided many of the right answers but it also became a strange and mysterious mixture of waves, equations, and particles that defied anyone's imagination to understand it. For seventy years scientists have been attempting to unravel the mysteries of quantum. Extremely complex structures and concepts have been nurtured in this theoretical soil. Some of them involve such enormous energies (‘quarks’ and ‘strings’) that even their authors agree that it will be 50–100 years before their theories could be tested in the laboratory, if at all. Until then, they are only speculation.

HINDSIGHT IS BEAUTIFUL. When easy answers to apparently difficult problems are discovered, many of us exclaim, “*Now why didn't I think of that! It is so beautiful and simple!*” This is the case with the old paradoxes of quantum theory, which were termed *wave-particle duality*. It appeared impossible that the experiments could be explained using particles alone; waves were necessary, so they were joined with particle and “Wave-particle Duality” began. Until recently, few persons even considered using just waves alone because when the science community tells itself for thousands of years that matter is made of little bitsies, it tends to believe itself. Not all thinkers followed this robotic path.

Choosing an unbeaten path were the great pioneers of 20th century physics: Clifford, Schrödinger, Mach, Wyle, deBroglie, and Einstein. They did propose that matter was composed of only waves. But their insight was abandoned by mainstream science. Nevertheless it has turned out that a wave-only universe is the simple answer to half a century of puzzles and confusion. All matter is structured of quantum waves. There are only two principles required to describe the waves and their consequences that underlie the science of physics. The waves will be described in the following pages.

SECTION I

SECTION II PRINCIPLES OF THE WAVE STRUCTURE OF MATTER



The structure and behavior of all the matter in the universe follows two basic Principles. These two principles are all that is needed to understand the laws of nature. The experimentally observed natural laws can be mathematically and logically obtained from them.

PRINCIPLE I says that there exists a quantum wave medium throughout the universe. Waves in the medium form the basic particles and their structure determines the rules of behavior of the particles. Erwin Schrödinger (*Life and Thought*, 1989) predicted that the structure of quantum waves forms the elementary particles (electron, proton, neutron, etc.). He wrote, "*what we observe as material bodies and forces are nothing but shapes and variations in the structure of space. Particles are just schaumkommen [appearances]*". That is, quantum wave structures are real; discrete material particles are not. Instead all matter is a wave structure in a quantum wave medium and material bodies are only their appearance to us. But he did not work it out, leaving that task for this book. The behavior of the waves is the origin of the laws. All the natural laws have this common origin, an amazingly simple breath-taking result.

PRINCIPLE II is based on a discovery by Bishop Berkeley and Ernst Mach a century ago, known as Mach's Principle. The math form of their discovery in this book provides the mechanism that determines the density of the wave medium. The simple rule is that *Medium density is proportional to the sum of the wave intensities of all the matter in the universe.*

PRINCIPLE III can be deduced as a result of Principle II. It is so useful and helpful in thinking about particle behavior that it is stated separately: "*The waves everywhere in space tend to adjust themselves to a minimum amplitude.*" This is called The Minimum Amplitude Principle (MAP).

THE MODEST ELECTRON.

This book includes an exciting description of the electron. Dull science? No! You will discover that the electron encompasses the universe. It is a fascinating journey in space without traveling anywhere! The first beauty of the adventure is that it is not complicated. Everything remains in our familiar three dimensions. Time does not warp and there are no black holes to swallow ideas just before you grasp them; just common sense unveiling a formerly unseen cosmology that is formed by the quantum structure of the electron and other particles. The second and most significant beauty is that this adventure with the electron describes the *fundamental origins of scientific laws* and is therefore of immense importance to science, industry, and society. The third beauty is that the quantum electron is real. In short, it describes the *physical reality* of Nature, sought by natural philosophers for thousand of years.

What is the quantum-wave world? Look around the room in which you are reading this page. Everything: your book, the walls, chair, the surrounding air— every atom, every electron, every proton is structured and joined together by the rules of *quantum waves*. These rules describe what was named “particles” that are actually structured of waves, traveling in the medium of space around us. Understanding the physical world demands learning the rules of these waves. It is not difficult. In fact it is simple, but requires a new way of thinking. These waves are everywhere. They form all the matter we see everywhere: in our houses, our planet, our galaxy, the universe. But nature has not made it obvious for us to see the waves, only to see the matter “particles” formed by the waves. Thus in order to understand the quantum-wave world we must learn to think in a new way about the physical world around us.

HOW WE LEARNED TO THINK.

In early childhood we grow accustomed to our surrounding world as we perceive it through our senses. At an early age the fundamental notions of space, time, and motion are formed. Our mind becomes used to these notions so that later on, we believe that our first concept of the physical world is the only correct one. Changing it seems paradoxical to us, but the physical world is not the childhood world. This is because nature has limited the range of our senses. This book will enable you to expand your senses and understanding to include the whole of the visible universe.

Our childhood judgment fails to comprehend the quantum-wave world because Nature gave us no direct way to experience it. We don't easily see the space wave medium because our survival as an animal species depended mostly on our ability to fight with other animals seeking food, and to compete for mates that produce children, not closely related to the quantum space medium. In the past million years of evolution Nature has equipped us with sensing mechanisms that aid survival. Sensing the space medium

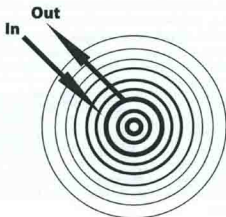


Figure 2.1. The wave structure of an electron. Spherical waves in quantum space converge to and diverge from a wave-center where the inward waves change direction and rotate to become the outward waves. This rotation produces the mysterious spin of particles. These waves exist all around us, but are unseen. Energy exchanges occur at the center, so laboratory measurements appear like a ‘point particle.’



was useless for survival, we did not need it, and we have no direct sensing mechanism for it.

Recognizing our adaptation for survival is very important for science and technology. If we insist on using only our ordinary senses we overlook the reality of Nature. Bees can sense the polarization of light. Birds can sense the magnetic field of the Earth. Dogs can sense high frequencies. These special senses help their survival. But humans cannot sense those things because it is not necessary for our survival; we humans, including scientists, are blind to the reality of quantum space. The difference is a matter of Nature equipping each species with what is needed to survive. However simple lab apparatus enables us to detect the presence of the quantum space around us, which we ourselves do not perceive.

In fact quantum waves are much simpler than, for example, the complex modern society we deal with every day. The most common atom, hydrogen, is composed of spherical quantum waves much simpler than those inside a violin. Nevertheless we feel they are mysterious because we seldom experience them. They don't behave like a baseball or a horse. Few of us spend much time poking into violins so it is little comfort to know that quantum waves are simpler than waves in the violin. As a result most people (including scientists) prefer to imagine that the electron is a "particle" like a baseball or a bullet that they have personally experienced. Laboratory evidence does not support this human preference. Instead an electron is a wave, structured out of an immaterial something variously termed ether or space or vacuum.

Figure 1.1 shows the simple wave structure of an electron, which fits all the laboratory-measured properties better than the classical discrete point particle model.

THE GROWTH OF NEW SCIENCE.

The production process of new science has many facets; research and experiment are just part of it. Like a plant, more is needed than just seeds and a gene structure to direct the growth. Fertilizer, sunshine, water, a favorable climate, and freedom from destructive competition from other living species are also necessary. The growth of science is similarly nurtured or retarded by its economic, social, and political environment. Thomas Kuhn (1922-96) of MIT wrote a book on this topic, *The Structure of Scientific Revolutions* (1962). He describes how tradition, stubbornness and politics affect the growth of revolutionary science.

What happens when a researcher discovers a new aspect of the physical world that at first sight is difficult to believe? For example, Copernicus's solar system, or the quantum theory in 1920. Before these can be accepted, many scientists have to change their minds about reality. In principle, any mind can change if presented with new facts—but it isn't easy. In this book, I want to convince more open-minded readers that particles are structured of waves. No mass or charge substance, just waves. I hope that we can make a successful leap across scientific cultures.

THE START OF MY ADVENTURE. My quantum adventure began in 1984 while wondering how an electron can be constructed of waves yet sometimes look like a particle. I read the thoughts of outstanding scientists and following their advice sought a wave equation for waves in space. I solved it and the solutions became a peephole where I saw the structure of the electron. As the consequences of the solutions expanded, the hole grew to become a window, then a greenhouse, and finally a vista of the universe and the future of micro industries.

My first surprise was to find that two thorny natural laws, quantum theory and the mass increase of relativity, were a single result of the wave structure of the electron. It was hard to believe. I recalculated. It was not only correct but also simple. Then, other natural laws appeared in view. Finally it dawned upon me that the space around us and the waves of electrons were the origin of all the natural laws themselves. Empty space had become exciting! It is breath taking to see the puzzles of the universe unfolding before your eyes. It was like solving a jigsaw puzzle. First, you poke around identifying patterns, then suddenly: *Ah! Another piece fits in place and then all fit together.* A window into space is opened. This book describes my theory of the electron, the fundamental particle of the structure of the universe, as made out of two connected spherical waves, an in-wave and an out-wave, where the center of the two waves is what we humans perceive as "the particle". I term this structure a "space resonance."

I believe in this theory because it is simple, because it follows all the known natural laws, it solves the main enigmas of particle theories, it does not require strange dimensions or alternative particles, and because it fits with the empirical evidence. In my journey to understand the electron, I have tried to be as clear-thinking as possible. However, ideas are not good because they are new, nor are ideas bad because they are old. In fact, as you will see, much of the foundation of my theory lays upon very old ideas. I ask, you the reader, to be skeptical. There may be errors in my theory; in fact it would be surprising if I have not made any. It is up to you, reader, to find my errors and let me know, or to join me in celebrating a very major discovery in the structure of the universe!

INTELLIGENT PHILOSOPHERS CAN DIFFER.

Discussions on the origin of the Laws of Nature have occupied men's minds for thousands of years and history has demonstrated that there are often conflicting views. A view championed by Niels Bohr called the Copenhagen Doctrine claims that: *There are limits to human understanding; We must accept the mathematics of the quantum laws as we find them and abandon further inquiry of their origin.* Bohr used this argument to defend quantum theory whose mysteries seemed impenetrable. This view is essentially religious where "Nature" has become the supreme god whose commands we are forbidden to probe. The contrary view was that of Einstein who argued, "The most puz-



zling aspect of the Universe is that we can understand it." He countered Bohr with a famous phrase, "God is subtle but not malicious."

In this search I have found that Einstein's view was right. The journey has been fruitful. The origins of the Natural laws have become clear and the mechanisms, which bring them about, are logical and, as many philosophers have already pointed out, Nature chooses the simplest schemes. But this newly discovered treasure of ideas is still to be explored fully. I have learned much but it is tiny compared to the valuable industrial applications that beckon to the readers. If you are a pioneer, why not join the adventure?

The electron structure also reveals an intimate connection between particles and cosmology. The physical world seen through the new window is comprised of particles formed totally of waves, each of which reaches out to the ends of its universe, mixing with and contributing to the fabric of the whole. Each electron or charge is thus an intimate part of the fabric of the cosmos. The unseen fabric was already suspected by many quantum physicists who dubbed it "the vacuum", "the new ether", or just "space". Now, space, once regarded as empty, is promoted to center stage as the medium of the waves and the raw material of the matter of the universe.

Why has this panorama been unseen if it is everywhere around us? It is because Nature has not equipped us with wave sensors because they are not needed for our survival. Quantum waves, unlike electric waves, do not stimulate energy exchanges in our existing human senses. Thus quantum waves ordinarily cannot be noticed. Another reason is the subtlety of the clues that tell us all particles are affected by other particles in their universe, although this was recognized by Ernst Mach 100 years ago, who asserted: The laws of inertia are established by all the matter of the universe. We will see that his assertion is true not only for inertia but for other natural laws as well.

A long-standing puzzle has been our inability to decipher the wave-particle duality paradox: "How can a particle simultaneously have properties of a point mass and a wave?" This paradox is resolved simply by discarding the point-mass notion of a particle. When the point-mass is gone, the paradox disappears. But this proposal at first is like advice given to the mice, "Just put a bell on the cat!" The mice object, "How do you do it?" For an electron, the answer is this: find a wave structure with wave properties that appears to us in the lab as a mass and a charge. The wave properties must duplicate the electron's appearance. That is they must exchange energy and produce forces in the same way. Erwin Schrödinger proposed this about 1938. In the following pages we shall see that he was correct.

Are you convinced or is your mind already made up? If you believe the Copenhagen Doctrine that both waves and "mass substances" exist, then you will disagree with this book. On the other hand, if you already have the habit of not prejudging nature before you have all the facts, your knowledge will leap ahead.

HOW REAL IS EMPTY SPACE?

Sir Arthur Eddington, British astronomer and Nobel laureate, pointed out in 1927 that the public has focused its attention on an uprooting of time and



space called "relativity". However in his opinion, the most important contemporary discovery was that solid matter (the table holding his book) was composed almost entirely of empty space! Eddington referred to two tables, one was a "commonsense table" and the other was a "scientific table" of quantum waves. He pointed out that the latter was a lot more reliable for describing physical behavior.

Similar to the idea of Eddington, the purpose of this book is to describe recent research showing that matter is composed entirely of waves in space. It will settle the controversy of the dual particle-wave nature of the electron.

FUTURE VALUE OF RESEARCH.

The investigations by Wolff (1990-93) produced a wave structure of the electron that agrees with scientific laws and laboratory measurements. The behavior of the electron's extremely small waves creates a particle-like appearance. The rules of these waves also contain the origin of all the physical laws governing the behavior of matter, such as quantum theory, relativity, and force laws. Because the natural laws underlie physics, the new electron structure opens enormous windows of opportunity in science and technology. For example, recall that the semiconductor devices used in computers and high-speed information transfer depend on the rules of quantum mechanics. The frontiers of research of molecules termed nanotechnology and bio-molecules for health application may benefit immensely from knowledge of the wave structure of matter.



SECTION II

SECTION III THE SEARCH FOR TRUTH AND REALITY

Figure 2.2. The first cyclotron at the U. of California - Berkeley. This historical monument is located two hundred yards downhill from the author's home. This machine, one of the first particle accelerators was instrumental in beginning the era of point-particle research in the USA. Government money grants stimulated particle research to the exclusion of quantum waves.

Why have scientists have taken so long to discover the obvious structure of the electron and other particles? Research by the pioneers of physics almost found this structure a hundred years ago. But there is more than research involved. The answer to the puzzle is found in economics, politics, and sociology—many facets. There have been political battles within science, and outside of science by men who seek to control it. Scientific thinking is strongly affected by ambition and tradition because most scientists, like most people, want to have bread on the table and a secure life for their family.



We may imagine scientists as noble pioneers. But the history of scientific breakthroughs tells an entirely different story. About a century was needed before the Roman Catholic Church was willing to relinquish its philosophical hold on the structure of the solar system in favor of the discoveries of Galileo, who was arrested and tried for disputing the church. The theory of the tectonic movements of continents on the Earth was scorned for 40 years, and the underlying theory of expansion of the Earth, by Warren Carey, is still disrespected and almost unknown. The unveiling of the DNA structure of the genes of life is now famous and credited to scientists Jim Watson and Francis Crick, but its sordid history reveals many personalities involved in a mean-spirited milieu of scientific competition.

The search for the structure of the electron was halted at the end of World War II when a vast government community of high-energy scientists was formed to search the streets of physics for new weapons. The path followed was the use of expensive high-energy accelerators. These were increasingly larger machines modeled after the cyclotron of Ernst O. Lawrence that is now used as an antique display, (shown in the above photo). It sits in front of the Lawrence Hall of Science at the University of California, Berkeley, two hundred yards from the home of the author. Government funding has made the Berkeley National laboratories larger than the educational campus.

When high-energy weapons did not materialize, the science-community instead promised new energy sources to maintain their financial backing. No sources have been found. The US Congress wisely cancelled funding for the most ambitious ten billion dollar machine in Texas. The latest promise requests high-energy funding to find quarks in the cosmos.

SECTION IV INTRODUCTION TO THE FOLLOWING CHAPTERS

I will describe several interesting applications of the new wave structure. In particular, we will see that —as Eddington proposed—there are really two interpretations of our world that we observe. One is the world of our human senses: material objects, light, color, sound and motion, that we interpret with a brain intended to help our survival as biological organisms. The other is the world of quantum waves that constitute the matter and energy around us, but we do not perceive it clearly because it is part of the microscopic quantum world and is not closely related to our biological survival.

The concepts presented here are still expanding and awareness of them is growing among scientists. So you, the reader, are also a pioneer of the new structure of matter. You should be aware that you are evaluating the fact that all science results from only two assumptions about the properties of space. It is a big responsibility; the opinions of readers can be significant in advancing science.

Some of this material has been described in my earlier book: *Exploring the Physics of the Unknown Universe* (1990), as well as in science journals. However, some ideas in this text are set in print for the first time. They may be flawed. New ideas in science are not right just because they are new. Nor

are the old ideas wrong because they are old. A critical attitude is required of every scientist and reader to evaluate them. How close to the mark are these new ideas? Finding natural reality was the goal of philosophers for thousand of years. Without immodesty, we state that we need search no further because reality is a result of the Wave Structure of Matter. We shall see that space is the medium of the quantum waves and the quantum waves, as resonant structures, are matter. Everything is made of waves and space. Now the goal of science is to find the consequences and applications of the Wave Structure of Matter, and most perplexing, the origin and meaning of space.

ORIGINS OF NATURAL LAWS.

The business of physics is the abstract quantification of facts observed in nature. The rules we form for calculation of observed facts we call laws of nature and Principles of nature. Principles are considered to be more general and by implication more basic. For examples, the Principle of Least Action is inferred from several of the force laws, and the principle of Conservation of Energy expresses all the various laws of heat and energy flow.

Since classical laws were obtained by measurement of nature rather than derived from other knowledge, they are by definition empirical and "of unknown origin". Therefore if we seek to find the origins of laws we cannot use the laws themselves but must use other observed facts together with logical deduction and established mathematics. We must be prepared to find unprecedented perspectives of nature. Ernst Mach (1893) observed that the basic laws are involved with cosmology; they depend on relationships between particles and the whole matter of the universe.

When seeking origins, it is important not to inadvertently use the existing laws to deduce themselves. Such circular reasoning occurs if, for example, charge, or mass, or an e-m field or mechanical device from macro-physics is assumed to be the structure of a quantum particle. This is self-defeating logic.

Finding the origins of existing laws requires forming new concepts that nevertheless satisfy observed data. This book will describe how the natural laws originate from the quantum waves of the basic particles (electron, proton, etc), that depend on all other matter in the universe. One example of this is already known as Mach's Principle, which asserts that every local inertial frame is established by the composite matter of the Universe.

The discovery of these origins creates a new picture of the physical world: Our limited five senses only tell us the physical world is real and all else appears as empty space. But our laboratory measurements force us to conclude that empty space is filled with unseen quantum wave centers - oscillating and in communication with each other. Quantum waves in space are the actors on the stage of the universe. Studying the waves enables us to learn the origins of forces, explain puzzles and paradoxes, and find relationships between microphysics (electrons and particles) and the universe (cosmology).



USING PUZZLES AS CLUES. In the search for the origins of natural laws, puzzles of quantum particles and cosmology are fruitful sources of input data. A clever detective regards puzzles and paradoxes as important clues to the case he wants to solve. Similarly, laboratory measurements that we cannot understand are probably Nature telling us, "Hey! Decipher this paradox and you may reach your goal." Since our goal is to understand matter and the natural laws, we must carefully examine her puzzles. Shall we look?

IS THE ELECTRON A WAVE OR A PARTICLE? The electron exhibits properties of both particles and waves. However, many searches have been done for a particle core of the electron, without results. What we do observe is that energy exchanges take place at "point-like locations" in the metallic lattice of detectors. On the other hand, wave properties of an electron are obvious from the success of Quantum Mechanics. Nature seems to be telling us the electron is made of waves that interact at point locations in such a way as to appear particle-like. How is this to be interpreted? Is the particle-appearance due to the waves or maybe the detector?

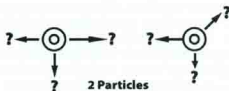
WHAT IS THE MECHANISM OF ENERGY EXCHANGE? Exchanges between charged particles are almost universally the way in which energy is transferred in our galaxy. In our lab an exchange is always required to darken a film, move a needle, record a bit, or fire a neuron. These exchanges dominate our technology, daily lives, and Nature. They are the means of our human senses, laboratory experiments, and the production of knowledge. We know how to measure and calculate energy exchanges but up to now the mechanism had been unknown.

An Energy Exchange Mechanism must underlie the force laws, mass change of special relativity, the DeBroglie wavelength, and Conservation of Energy. For example, the force laws describe force F as the change in energy dE over distance dr ; or generally $F = dE/dr$. Therefore, whatever motivates the change in energy generates the force. The classic Coulomb and gravity force laws do not describe what creates these forces; they only provide formulas to calculate it. That is, the classical rules do not contain an energy exchange mechanism.

The missing energy exchange mechanism is very important because energy transfer is the principal property of most particles! The missing mechanism is at the heart of many paradoxes. Unfortunately, the lack of a mechanism

Figure 2.4.

The missing Energy Exchange Mechanism. Nature has a rule for energy exchange in force laws but we didn't know how she does it. Now the energy exchange mechanism is found, it logically leads to understanding the origins of the force laws.



$$\text{Force} = \frac{(\text{property 1}) \times (\text{property 2})}{(\text{separation})^2}$$

How is each particle able to carry out the law?



has been hidden by using names like “mass” and “charge” in the formulas for force. These words suggest a mechanism, so you don’t notice the mechanism is not there. The puzzle of the mechanism is shown in Figure 2.4.

HOW DOES MATTER DEPEND ON OTHER MATTER IN THE UNIVERSE? We can deduce the properties of particles by logically examining the relationships that exist between particles in order to produce the natural laws we already know. These important particles are the stable particles of the universe, mostly electrons and protons.

It is fashionable in science to insist on the use of mathematics to deduce the properties of Nature. This fashion can be justified when we recognize that indeed Mother Nature is a mathematician; it has usually been found that natural laws are best expressed using mathematical formulas. Nevertheless, significant discoveries of the mysteries of nature and the cosmos are also found using logical thinking; available to readers who are not equipped with a laboratory. Below, seven new concepts are identified in this way.

THE MEANING OF PARTICLES, LAWS, AND THE UNIVERSE.

First, consider that mere existence of particles and laws imposes requirements upon their properties. Without particles to populate a universe, the universe is meaningless because our concept of “universe” is simply a collection of particles and their distribution. Thus our understanding of our universe depends on our understanding of the particles in it. Further, the natural laws of the universe could not exist without particles; Laws demand the presence of particles, upon which the laws can operate. Laws without particles are meaningless because particles are the objects of the laws. Especially important are the relationship of the electron and proton, because their infinite fields dominate the universe. And the opposite is true. We cannot identify a particle without the force laws to locate and measure it. We conclude:

1) PARTICLES, LAWS, AND THE UNIVERSE ARE AN INTER-DEPENDENT TRILOGY.

Each requires the existence of the others. We cannot expect to understand cosmology and the structure of the universe, unless we also understand the relationships forming the trilogy. These relationships are found in the following conclusions.

2) MEASUREMENT IS A PROPERTY OF AN ENSEMBLE OF MATTER. A particle entirely alone in the universe cannot have dimensions of time, length, or mass. These dimensions are undefined without the existence of other matter because dimensions can only be defined by comparison with other matter. For example, at least five separated particles are necessary to crudely define length in a 3D space: four to establish coordinates and one to measure.

Thus the measurement concept requires the existence of an ensemble of particles. In our universe the required ensemble must include all observable matter, for there is no way to choose a special ensemble. The



importance of this concept becomes clear when we recall that time, length, and mass are the basic unit set used to describe all scientific measurements.

- 3) **PARTICLE PROPERTIES REQUIRE COMMUNICATION BETWEEN PARTICLES.** If there were no means for each particle to sense the presence of other matter in its universe, the required meaning of time, length, and mass could not be established. How can particles possess a property dependent on other particles, if there is no way for the particles to impart their presence to each other? Without communication, each particle would be alone in its own separate universe. Therefore continual two-way perceptive communication between each particle and other matter in its universe is needed to establish the laws of nature. The laws are established in terms of the dimensions (units) determined by the ensemble of matter. We conclude:
- 4) **THERE EXISTS A MEANS OF CONTINUAL COMMUNICATION BETWEEN PARTICLES** which takes place in the space (ether, vacuum) of the universe of the particles. From the electric force law we can deduce that waves of an electron structure must be the means of communication between them. In chapters 12–13, you can check that the mathematical solutions of the wave equation indeed produce two-way communication using quantum waves of the electron structure.

Another conclusion can be drawn concerning the significance of the ensemble of particles that establishes the measures of length. This is the ensemble we think of as the Universe. Accordingly:

- 5) **FOR EACH PARTICLE A UNIVERSE IS DEFINED AS THE SPACE, AND OTHER PARTICLES WITHIN THAT SPACE, WHICH ARE ABLE TO COMMUNICATE WITH THE PARTICLE.** For example, on Earth we are unable to communicate beyond a distance larger than the range of light traveling during our existence. No meaning can be attached to things outside of this range. This is often called the Hubble Universe. It is clearly important to recognize that the size of this universe is not infinite! This is lucky because an infinite size creates paradoxes.
- 6) **THE MEASUREMENT OF TIME REQUIRES A COSMOLOGICAL CLOCK.** Using reasoning similar to the above we can conclude that the properties of particles which involve time, notably velocity, frequency and mass, cannot have a meaning if particles themselves have no scale of time for reference. That is, the particles must have a way to compare their own time behavior with other particles. Such a 'clock' requires the existence of cyclic events in the particle. All particles must contain the same clock because all particles obey the same natural laws. Therefore:

One proposal by DeBroglie is a cosmic clock contained in every identical particle structure as an oscillator. Because of the uniformity of space (medium of the oscillators) all clocks would be alike thus all particles would have the same time scale.

- 7) **THE ROLE OF SPACE.** If all the laws of nature use only the dimensions of time, length, and mass, defined by the ensemble of communicating mat-



ter in a universe, the medium of communication, space, must affect the laws. For example if the medium were not uniform we would notice slight variations in the laws. This is found to be true. We infer that the behavior of matter is at least partly determined by the properties of the communication medium (space, ether) within the universe.

Einstein's general theory of relativity (GTR) describes the properties of space that determine the large scale motion of matter and light beams. We have deduced above, and will find, that laws in tiny quantum particle space also depend upon total matter in the universe. But there cannot be two different properties of the same space. Therefore, the properties of quantum particle space, when applied to large scale matter, should include the GTR. For example, the cause of bending of light rays near the Sun should be a quantum property that resembles a refractive index. In other words, the GTR is also part of the quantum particle space.

- 8) **DEFINITION OF OUR FINITE UNIVERSE.** Conclusion (5) above states that each particle exists in a universe consisting of the matter and space inside the communication range of its waves which are assumed to have existed for a time T . The radius R of this universe is finite and equal to light speed divided by the lifetime $R = c/T$. This assumption has been popular in cosmology because there are fewer problems if all galaxies of the universe are the same age.

However if new matter is created continually, the ages T are different. The strange possibility exists that different electrons may have different ages and thus different radius R and numbers N of particles within their universes. This leads to a different mass of the electrons and different wavelengths of hydrogen radiation (called a red-shift). Narlikar and Arp (1994) proposed this assumption in order to explain the unusual red shift of quasars and avoid their unbelievable bizarre features. A dependence of mass upon age provided them with an origin of the Hubble red shift without making the bizarre assumption of the Big-Bang (Arp, 1993). Distant objects would be seen at an earlier "look-back" time at a younger age, a smaller mass of the electron, and a redder radiation than earthly hydrogen atoms.

ORIGIN OF QUANTUM MECHANICS AND SPECIAL RELATIVITY. Quantum mechanics and special relativity seem unrelated, but they have one feature in common: Both laws depend on the relative velocity between two particles. Noticing this, our curiosity immediately demands to know, "What happens when two space resonances are in relative motion?" To answer this, you write the equations of a space resonance with its waves modified by the well-known Doppler effect with relative velocity. The two resonances see each other alike because each receives the same Doppler shifted waves from the other. Their in-waves are red-shifted and their out-waves are blue-shifted according to the Doppler rules. The amplitude received at each resonance is the sum of Doppler-shifted in- and out- waves from the other.



The results are remarkable. The Doppler rules curiously alter the combined in- and out- waves in a special way so that each resonance sees the other with its momentum and mass (rest frequency) increased by the factor $[1-(v/c)^2]^{-1/2}$. This is just the relativistic mass increase of moving particles! The curious feature is that this cannot happen without involving both the in- and out-waves. Doppler alone is not enough.

What about quantum theory? The Doppler effect of the relative motion also causes the electron waves to be modulated with a deBroglie wavelength $\lambda = h/mv$. Recalling that this is the original experimental basis of quantum theory, we conclude that quantum theory is also a fundamental property of the space resonance, symmetrically dependent on both the in- and out-waves. Of course, it has long been known that both advanced and retarded waves are an integral part of quantum theory but up to now they were only thought to be "probability waves". Here we see them in the real structure of the electron and as the origin of quantum theory itself.

AN INTER-DEPENDENT UNIVERSE. The most extraordinary conclusion of the Wave Structure of Matter is that the laws of physics and the matter structure ultimately depend upon the total of all matter in a universe. Every particle communicates its wave state with all other matter so that energy exchange and the laws of physics are properties of the entire ensemble of matter. Mach's Principle, which conspicuously displays inter-dependence of matter, is just one of a family of inter-dependence principles.

In the following chapters, we will look more closely at these properties of waves in space and their applications.

CHAPTER

THREE

THE MYSTERIOUS ELECTRON

- I. Einstein's Last Question: What is an Electron?
- II. Solutions of the Scalar Wave Equation.
- III. The Two Principles of the Wave Structure of Matter.

*"Wrong does not cease to be wrong because
the majority share in it."*

– Leo Tolstoy



In this chapter we describe the electron wave structure, termed a space resonance, in more detail. It replaces the ancient notions of discrete solid particles, credited to the Greek Democritus, that have been mistakenly adopted in varied forms by scientific communities for many centuries past. We will provide the logical arguments, already recognized by Einstein and other natural philosophers, why a wave structure is the only possibility for the basic structure of matter. This wave structure of the basic element of matter, replacing the old notion, is the central feature and new paradigm of this book. Making this single replacement step has opened an enormous window of understanding of science, life, and the universe. It also writes *finis* to the present scientific confusion, paradoxes and puzzles created by the use of, non-existent discrete "particles". Further details of the wave structure of matter are described in the following chapters and mathematical proofs are in the appendix.

SECTION I
EINSTEIN'S
LAST QUESTION:
WHAT IS AN
ELECTRON?

During his later years, after he had become famous for the General Theory of Relativity, Einstein was asked his thoughts about the huge numbers of short-lived heavy 'particles' with exotic names like, kaons, pions, quarks, mesons, etc. that were found using high-energy accelerator machines. Enormous amounts of time, money and labor were spent measuring these particles, classifying them, and seeking new ones. The physicists involved thought that they were finding new important basic matter. Therefore they wanted to know what Einstein thought of their work. They were probably concerned that perhaps only protons, neutrons and electrons were basic elements of matter because all the exotic 'particles' are unstable and decay quickly into these basic three. Einstein was a careful thinker and not given to theatrics so he was very serious when he made a reply. *"I would just like to know what an electron is."*

Why did he say this? His answer implied, contrary to popular thinking, that the pedestrian electron, known since Greek times, was more important to science than the results of billions of dollars of government money being spent every year on accelerator machines. Little attention was paid to his reply. Instead the physics community raced ahead to build bigger, more powerful machines. High-energy physics became a growth industry.

He saw the electron as the leading player in the universe, as did any careful thinking scientist because energy transfers attributed to the electron dominate most of the activity of the Universe. Knowledge of the importance of the electron was available to anyone who cared to think and look. For example, the wide variety of matter in the Universe begins with the Atomic Table of the elements. A large number of combinations create an enormous variety of molecules using a tiny number of elements. These combinations are produced by properties of electrons associated with central protons and neutrons. We want to know how it happens.

Another example: Most of our knowledge of the vast Universe of stars and galaxies is provided by light entering our telescopes; that is the result of an energy transfer between the electrons of atoms in the stars and the retina of our eyes. Until recently we didn't know how an energy transfer takes place. Einstein had thought deeply about this. He realized that the properties of the electron probably depend upon the existence of all the matter of the universe as asserted by Ernst Mach in 1896. This implied that all matter in the Universe, including life, is inter-connected. The truth of his thought, however logical and apparent, had not yet been proven. This is a role of this book.

A root problem of these puzzles is because neither Einstein nor anyone else fully understood the causes and mechanisms of light energy transfers between molecules and atoms. Although the 'force' between electrons could be calculated using the rules taught in introductory physics classes, the suggested mechanism does not stand up to logical examination. The nature and structure of the electron itself was in question. It did not appear to be a discrete material particle. Something was wrong and Einstein knew it.

WHAT KIND OF A PARTICLE IS THE ELECTRON? When J. J. Thompson discovered the electron in 1904 using cathode-ray tubes that enabled him to calculate the charge to mass ratio, everyone was convinced that electrons were discrete material particles. Later this belief - that each electron had a material identity - began to be questioned by quantum mechanics and the Schrödinger Equation used to calculate *wave functions* of electrons. These functions can be attached to individual electrons if one assumes that each electron has an identity. On the other hand, the Schrödinger Equation also allows one to assume that material electrons do not exist so the wave function is the entire electron. It is up to you to choose an interpretation. The math of the Equation is neutral and takes no position. However the evidence goes well beyond personal choice because there are strong scientific reasons for rejecting the point material particle as the structure of the electron in favor of the wave-only choice.

ENERGY TRANSFER AND THE ACTION-AT-A-DISTANCE PARADOX. To understand the electron we need to understand the mechanism of energy exchange. Experience tells us that communication or acquisition of knowledge of any kind occurs only with an *energy transfer*. Storage of information, whether in a computer disk or in our brain, always requires an energy transfer? Energy is required to move a needle, to magnetize a tape, to stimulate a neuron. There are no exceptions. This rule of nature is embedded in biology and our instruments. Finding the energy transfer mechanism between particles is essential to understanding the electron and the natural laws. Unfortunately science has largely avoided this question by saying, "A photon does it." But no one knew what a photon was.

A major deficiency of classic force laws is that they have no theoretical or physical *mechanism* for energy transfer. The formulas contain only constants, "mass" and "charge," - no mechanism. This was also an inherent defect of the



static point particle model. Einstein, Wheeler and Feynman knew this, recognizing that there must exist a continuous means for forces to transfer energy and at first sought it in electromagnetic waves. Unfortunately there are no spherical solutions of the electromagnetic wave equation so this was impossible. Hence the mechanism had to await the scalar quantum waves. We will see in this book that scalar quantum-wave communication is the mechanism.

MATTER AND THE UNIVERSE ARE INTIMATELY INTERCONNECTED.

Ernst Mach's observation in 1883 was the first hint of the mechanism of cosmological energy transfer. He noticed that the inertia of a body depended on the presence of the visible stars. He asserted: *"Every local inertial frame is determined by the composite matter of the universe"* and jokingly, *"When the subway jerks, it is the fixed stars that throw you down."* His deduction arose from two different methods of measuring rotation. First, without looking at the sky one can measure the centrifugal force on a rotating mass m and use the inertia law $F = ma$ to find circumferential speed and position, as in a gyroscope. The second method is to compare the object's angular position with the fixed (distant) stars. Both methods give exactly the same result! Thus the matter of the Universe is the cause of inertia.

Mach's Principle was criticized because it appeared to predict instantaneous *action-at-a-distance* across empty space. How can information travel from here to the stars and back again in an instant? It cannot. But it need not. Instead, the solution of this two hundred year old enigma lies in transfers directly to the *space* around an accelerated object. Inertia, charge, and other forces are mediated by the pervasive space medium. There is no need to travel across the universe. But this appears like a transfer to the stars because the quantum wave medium is created by waves from every particle in the universe.

Einstein and other philosophers realized that matter is inseparable from the space it occupies. *"Space is a medium of the particle and particles are part of the space"*. But as humans we don't easily see the space medium because our survival as an animal species depends mostly on our ability to fight with other animals seeking food, and to compete for mates that produce children. Observing the medium would not help our survival. For survival, it doesn't matter what space is, or whether we can observe it - it exists nevertheless as the wave medium. Our notion of point material particles is a human-oriented logical mistake because of our inability to recognize the wave medium of space. In our self-focused human perspective few of us are even aware of the wave medium in which we exist.

Traditional science has tended to comprehend the universe in terms of our own local experiences. It was assumed that matter particles are like tiny grains of sand. As microscopy improved, models were created subdividing grains into smaller grains. But only a few people like Einstein saw that grains were impossible or ever asked how the grains communicate forces - unexplained by the old science. Formerly, forces were accepted as religious faith in Nature.

A wave structure of matter was proposed 140 years ago by the famous English geometer, William Clifford, who wrote in 1876, "*All matter is simply undulations in the fabric of space.*" In Clifford's thoughts, the mass and charge substances we assume do not exist but are properties of a wave structure in space. In short, waves are real, while mass and charge points are mere appearances of the wave structure.

In 1937, Schrödinger proposed to eliminate point particles by using a quantum wave structure. He wrote: *What we observe as material bodies and forces are nothing but shapes and variations in the structure of space. Particles are just schaumkommen* (appearances). That is, quantum waves structures are real and material particles are not. This book will show that Clifford and Schrödinger were right.

RESEARCH FOLLOWS THE GOLDEN PIPER. Despite the thoughts of these leading scientists, the high-energy physics community since WWII has ignored the need to understand the structure of matter especially the electron. Instead, research has followed the tunes of the two pipers who pay most generously: One, the government seeks weaponry from high energy physics. Two, the information technology industry spurred the growth of transistor chips and computers in the decade of the 1990s. Money of Silicon Valley continues to flow into the basic research of information technology, optical displays, microchips and nanotechnology. Some is now beginning to support the WSM [See Carver Mead, 2000].

Most scientists and the textbooks they write still believe in the point material particle and related older laws. The laws of physics they write ignore the connection with the stars, galaxies, and the universe that Mach and Einstein knew and you, the reader, can demonstrate spinning on a piano stool. Just this simple experiment shows that life on the Earth is greatly dependent on the presence of the distant universe. But if you propose this to an ordinary scientist, he will look at you with disbelief.

THE ORIGIN OF THE NATURAL LAWS. Our knowledge of science and the universe is based on a few natural laws that govern the behavior of particles. These laws are the rules for calculating electricity, gravity, relativity, quantum mechanics, conservation of energy and momentum. The origin of these laws was unknown. Now the origin of the natural laws is found to be a quantitative result of the WSM.

The origins of the laws had been sought for centuries. Finding all of them at the same time and place is a philosopher's dream come true. It is an astonishing breakthrough of great importance to applied science because the natural laws and spin determine the structure of the Atomic Table which dictates the varied forms of matter: metals, crystals, semi-conductors, and the molecules of life. The deep understanding of basic physics that is revealed opens another door to broad fields of applied technology such as integrated circuits, photonics, and energy storage.

Finding these origins was very simple. You simply replace the ancient Greek notion of a point particle with a *spherical wave structure*, which had already been predicted by Clifford 150 years ago, and Einstein and Erwin Schrödinger, seventy years ago. Nothing complex but it is different because it reveals a universe of real quantum wave structures that we live in but seldom see. Why had this not been found before? Because no one had looked! Unfortunately, the Democritus particle agreed with human emotional experience so most people were satisfied with it. Engrained habits are hard to displace. Happily, Nature has made the true structure of the electron, proton and neutron very simple, a pair of spherical waves whose center is the location of the particle.

DARWINIAN SURVIVAL AFFECTS OUR PERSPECTIVE. We don't easily see the space medium because our survival as an animal species depends on our abilities not closely related to the space medium. Traditional science has tended to comprehend the universe in terms of our own local experiences.

Human survival perspective has another emotional bias. We tend to see space as three rectangular dimensions, one of which is the vertical gravity vector of Earth, plus two other vectors perpendicular to it, shaped like the Earthly houses we live in and that protect us. On the other hand, the true shape of the enormous universe is spherical whose important dimensions are inward and outward, the direction of waves in space. In the vast expanse of the real universe, gravity occurs weakly, so that its direction is inconsequential in the larger scheme of the cosmos, despite its local importance to us.

THE ANSWER TO EINSTEIN'S QUESTION. A purpose of this book is to provide you with a complete answer describing the electron, its origin and role in the universe. Just as Einstein speculated, the electron is indeed the leading player in the universe and is intimately involved with matter, the laws of nature, and our lives. This exploration describes for the first time the *origins of scientific laws* and is therefore of immense importance to science, industry, and society. In short, it describes the physical reality of Nature, sought by natural philosophers for thousand of years. At the same time we will seek to understand why Einstein's simple question had lain dormant for fifty years, ignored by the science community, although it turns out to have a simple answer.

HOW TO VIEW THE QUANTUM UNIVERSE. The discovery of the wave structure of the electron and other matter is an adventure in which you find the origin of the natural laws, a new powerful tool of science, and an exciting window on cosmology as well as ourselves. But old ways of thinking must be discarded. For instance, a well-educated quantum physicist expects that all quantum phenomena must derive from Schrödinger's Equation. No! It is the other way around! Schrödinger's Equation and the laws are derived from the quantum wave structure of the universe. Understanding the physical world demands learning new quantum wave rules. They are few and simple, but one has to think anew and discard false rules, such as the material point particle. In their place we must deduce, as did Schrödinger, that location, charge and mass of matter are properties of the wave structure.

SECTION II SOLUTIONS OF THE SCALAR WAVE EQUATION



EINSTEIN'S QUESTION. Einstein wished to resolve the disparity between the experimental properties of the electron and the common discrete electron model. He also wanted to know why it appears that "God plays dice" according to the uncertainty interpretation of quantum mechanics that he did not believe. This required finding solutions to the wave equation in a quantum space predicted by Clifford and Schrödinger. There is only one mathematically valid choice in our 3D world: The Scalar Wave Equation. Wolff [1990], Mead [2000], and Haselhurst [2005] explored the Scalar Wave Equation and found that its solutions form a quantum-wave structure, possessing all the electron's experimental properties, eliminating the paradoxes of quantum mechanics and cosmology. This wave structure completely replaces the material particle. This is what Einstein wanted to know. Finding that the discrete particle electron does not exist, removes the Bohr interpretation of the wave functions and assures us that God does not play dice. The non-mathematical approach outlined below describes the electron, its origin and role in the universe.

WAVES WITHOUT MATHEMATICS. You need not be a mathematician to understand the wave structure of the Universe, so I have written the description below in ordinary prose. At the same time, I have also written some of the related equations. Why both? So you can verify that indeed both descriptions agree. You can read either or both, as you like. In addition you will have the important advantage of focusing on the conceptual origin of the equations that is often lost when algebra is the only goal.

THE SCALAR WAVE EQUATION IN SPACE. A wave equation is a description of the behavior of the energy in the medium of the waves. Like all wave media, the space medium of the WSM possesses an energy density measured in joules/cubic meter using metric units. When waves occur, energy of motion (= kinetic energy = K.E.) is changing back and forth with energy of position (= potential energy = P.E.). It is precisely this energy-exchanging property that can be written as a wave equation. There are always two properties of the medium that appear in the equation: One is the energy density that enters the term for kinetic energy. The second is the elasticity that enters the term for potential energy.

The universe abounds with things that oscillate, such as; the ocean surface, a violin string, a drumhead, a child on a swing, as well as the structure of electrons and atomic matter. A wave equation can be written for all of these that when solved describes position and motion of the waves. Some waves oscillate rapidly and some slowly; this depends on the energy density and elasticity. Similarly, the speed of the waves depends on the two factors. In the case of the space medium, the density is very large and the elasticity is very low. These produce a very high speed of the waves. In fact it is the highest known speed – the velocity of light c . When you combine both Principles II and I all the Natural Laws appear.



SECTION III

THE TWO PRINCIPLES OF THE WAVE STRUCTURE OF MATTER

PRINCIPLE I OF THE WSM STATES:

A quantum wave medium exists in 3D space.

This seems almost too simple but its simplicity is deceiving for its solutions contain more than half of the Natural Laws, including QM, conservation of energy, the mass increase of special relativity, and the relativistic energy equation.

To understand the electron we need to find and solve a wave equation in space. Since the universe is three-dimensional, the only choice is the well-known scalar 3D wave equation. It is not fruitful to consider the vector wave equation — so familiar in electromagnetic wave guides—because that has no solutions in 3-D space. Thus this step was easy—only one choice.

There are only two possible spherical wave solutions. Again an easy step: One is a spherical converging wave, termed an *in-wave*. The other is a spherical diverging *out-wave*. Both travel at the speed of light (c) and both come together at a common wave-center. This is where the 'particle' appears to be located because energy exchanges occur here. At the wave-center, the in-wave transforms to an out-wave, but in order to do this it must undergo a quantum rotation that produces the formerly puzzling spin of the electron. It matches the experimental value of: $\text{Spin} = \pm h/4\pi$.

To further understand the electron, go to the math appendix chapter for a discussion of the mathematics. There you will see the electron from an algebraic perspective that shows you the origin of some of the Natural Laws that are algebraic.

A third way to understand the electron is a visual perspective that tells you how it looks if you could bridge the enormous difference of size, which you cannot. However you can picture the waves in your mind as continually expanding and converging bubbles of energy as drawn in figure 3.1. But better yet - a trip to your computer will show you moving animated waves of the electron created in computer programs by four brilliant computer scientists. — The four best web sites are:

1. www.QuantumMatter.com/see.html (made by Winston Wolff in Berkeley, California. This was the first ever animation, 1994).
2. www.ryanbagan.net/mikel/StandingWave3D/StandingWave3D.htm (made by Mike Weber who is an officer on a US Navy nuclear submarine).
3. www.daugerresearch.com/orbitals/index.html (by Dean Dauger at UCLA, Los Angeles who won national prizes for this work while still an under-grad student).
4. www.SpaceAndMotion.com/physics.html (by Geoff Haselhurst in Nornalup, Australia, who was the first person to deduce the WSM on philosophical grounds).
5. www.geocities.com/glaefreniere00/matter.htm (by Gabriele Freniere in Canada).



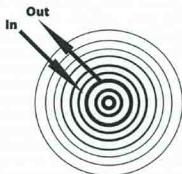
These animations show you how the two oppositely moving waves form a resonance (the electron) in space around a center. You can exchange ideas at a Yahoo discussion group:

<http://groups.yahoo.com/group/Wave-Structure-Matter/>

WAVES OF THE ELECTRON-POSITRON. The two in/out waves can be combined in only two ways to form the structures of the electron-positron as shown in the animations and Figure 3.1. These are combinations of the in- and out- spherical waves:

Electron = INwave — OUTwave with CW spin

Positron = OUTwave — INwave with CCW spin



The converging in-waves reverse direction at the center to become diverging out-waves. This reversal is expressed mathematically by CW and CCW spin-rotation operators on the waves. The operators cause either '3D clockwise' or '3D counter-clockwise' allowed wave-motions that do not tangle up the coordinates of space. The inward wave spins or rotates twice in a 3D fashion that transforms it to an outward wave as in Figure 3.1. The rotation fulfills a geometric requirement of wave continuity and produces the formerly mysterious quantum spin of value $\pm h/4\pi$. Both the amplitude of the waves and the direction of spin are opposite to each other in the electron and positron. This is the reason that electron-positron superposition produces annihilation. Notice how simple Nature makes the electron by choosing the simplest and only possible means of oscillating in free space! Also notice that Nature has chosen to construct the building blocks of matter always in just two forms. We live in a binary Universe!

Wheeler and Feynman (1945) sought to find how an electron radiates energy. They approximately described the behavior of the electron using electromagnetic waves; The WSM was not known at that time. Their description of the in-waves as a Huygens superposition of out-waves from other particles (absorbers) in the universe, shown in Figure 3.2, accords with other calculations. Missing from the W&F description was the 720° rotation of the

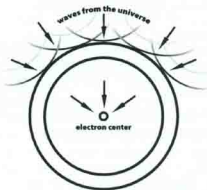
Figure 3.1.
The spherical waves of the electron or positron. Each is a pair of waves, one converging, one diverging that form a continuous resonant structure in space. The wave amplitudes of the electron are exactly opposite to those of the positron. Rotations of 720° at the center that transform in-waves to out-waves, are also opposite. The resulting spin = $\pm h/4\pi$. Thus, superposition of an electron and a positron causes annihilation since all amplitudes are opposite.

Figure 3.2.
Formation of

the in-wave. The spherical out-waves of an initial electron encounter other electron wave-centers.

At each encounter, a signature of the initial electron is transferred to the out-waves of the other electrons. The out-waves generated become a Huygens combination, the in-wave of the initial electron. This intermingled exchange of waves makes each particle like a 3D hologram of all others in the Universe.

Wolff [1990].



THE SECOND PRINCIPLE II OF THE WSM is used to calculate the density of the quantum wave medium – the space all around us. The role of the medium was foreseen in 1883 by Ernst Mach who noticed that the inertia of a body depended on the presence of the visible stars as written above. The energy exchange of inertia actually takes place with the space medium not the fixed stars. However it appears to be the fixed stars because they establish the density of the space medium. Principle II is:

Density of space is proportional to SUM of ((waves from all matter)/(each distance squared))

This SUM includes all the matter in a sphere with a radius equal to the Hubble Radius. Principle II shows the origin of the inertial energy exchange mechanism, formerly unknown and regarded as a paradox. The exchange is the interaction of waves from accelerated matter with the universal space medium surrounding it. This happens because space is not empty; it is a quantum wave medium created by waves from every particle in the universe. Inertia, charge, and other forces are mediated by the pervasive space medium.

Express this in another way: The matter of the Universe creates the wave medium in all space of the Universe. Thus the inertia of an accelerated object is an energy exchange to the waves in the space around it. As a result our observation of acceleration appears to be caused by the framework of the fixed stars. The laser gyro used in commercial aircraft is an important application of Principle II. You can experience rotational inertia yourself by spinning on a piano stool.

How is Principle II obtained mathematically? Wolff [1990] extended Mach's Principle by calculating the density of the wave medium as the sum of the amplitudes of the waves from every particle in the universe, each diminished by the inverse square of the distance. Knowing the density you can calculate the velocity of the electron waves, their amplitude and the motion of the wave centers. Their velocity c is almost constant everywhere because

there are so many (10^{80}) particles (mostly hydrogen) contributing waves but c varies minutely near large masses like the Sun.

It is important to realize that inertia is an interaction between an accelerated object and its surrounding space. You should not try to imagine that the object is interacting with the distant stars. Instead the density of the surrounding space is already created by the waves from the distant stars. This agrees with laboratory experience using gyroscopes, accelerometers, and the laser gyros that navigate aircraft. Before knowledge of the space medium, inertia was a paradox stated by Newton as: action-at-a-distance.

If you think Principle II over carefully, you will notice a strange feedback loop in Nature, as follows: *The matter of the universe combines to tell the space medium what it is and in turn the medium tells all matter how to behave.* In other words: The matter of the universe determines the particles and the particles determine the matter. How does this happen?

The reader may be inclined to disbelieve this strange result. But there are several confirmations, one of which is Einstein's General Relativity (GTR) which contains the same feedback loop: Reduced to basics GTR calculates the density of space-time at each point in space using the density of matter and energy everywhere in the universe. A varying density is referred to as curvature of space. This space density is then used to determine the paths of moving matter and of light which follow the curvature. Archibald Wheeler expressed this: *All the matter of the universe tells space how to curve and in turn space tells matter how it must move.* The feedback loop is the same. This is not surprising because we will find that all physical laws are a result of the WSM and its space medium. If GTR were not included this would be unexpected indeed. Nevertheless, this feedback in Nature is puzzling and perhaps the reader can deduce its cause. It will be discussed further in the Chapter on Astronomy and Cosmology.



CHAPTER FOUR

NATURE, EVOLUTION AND THE BINARY UNIVERSE

- I. The Measurement of Nature's Mathematics.
- II. Seeking the Origins of the Natural Laws.
- III. Nature's Mathematical Basis of Wave Structure.

"Most of us often encounter the truth but we usually pick ourselves up and pretend it didn't happen."

– Winston Churchill



There are intimate relationships between matter, the Natural laws, and the Universe that are inherent in the meaning of those words and also have the character of binary numbers. These relationships become clear and simple after learning the Wave Structure of Matter.

FLEAS AND OTHER TINY THINGS.

The idea that complex matter is formed of tiny simple structures has had an enduring emotional appeal, so the analogy of comparing matter to grains of sand has long been popular. Poet Ogden Nash whimsically compared particles of matter to fleas on a dog writing:

*"Fleas have smaller fleas,
And these fleas have tinier fleas upon 'um,
And so on, ad infinitum."*

This emotional error has had catastrophic consequences. It has culminated in the current Standard Model of the American Physical Society, derived from accelerator-machine experiments, where the big fleas are the hadron particles, lesser fleas are the leptons, smaller fleas are the 'quarks' and these are all joined together with bits of glue termed 'photons', 'gluons', 'gravitons', 'Higgs bosons', and other whimsy. There is no limit to the imagination of the Standard-model particles because, as Ogden Nash predicted, those fleas are generated without limit. This corresponds to the physical fact that the number of 'particles' observable will always increase as the energy of accelerator machines is increased. Clearly, the hope that such unlimited particles could underlie the structure of matter is a fantasy. But there are other reasons, economic and political, that explain why this futile search goes on, described in the following chapters.

RECOGNIZING TRUTH. We already know that the natural laws are empirical laws, or mathematical rules created to describe the experiments as best possible. However no origin of the laws is known since they are only mathematical rules to match experiments. This book shows the true origins are based in the Wave Structure of Matter (WSM). The intelligent skeptical reader asks, "How do you know the WSM is true? In reply: The test is that Laws contained in the WSM must correspond exactly with all accurate empirical measurements and the WSM must show the physical origin of these natural laws. These tests are satisfied, as we will see. Further, it is also found without exceptions that the WSM is inherently the origin of natural laws. Clearly, the WSM is a fundamental part of Nature.

Sometimes there are small differences between the form of the empirical laws and the experiments, as for example in the Coulomb law of electric charge. In this case, the WSM matches the experimental result and the common Coulomb rule is slightly wrong – a proof of the WSM. This difference happened because old laws were obtained by fitting a mathematical equation to properties of matter at macro dimensions. It missed the small changes at atomic dimension. But a complete law should be true for all dimensions.

SECTION I THE MEASUREMENT OF NATURE'S MATHEMATICS



As might be expected, knowing the basic structure of matter in nature should lead to new understanding of matter and laws, not previously known. This has already occurred; origins have been found for electron spin, gravity, the red shift, magnetic laws of micro-circuits, and other puzzles. But this is just a beginning. There is much more to be found in industrial applications especially nanotechnology. Perhaps you, the curious reader will join this exciting search.

THE SIMPLICITY OF BINARY WAVES. As is usually found for most truth in nature, the space resonance, the wave structure of matter, is very simple – in fact it could hardly be simpler being composed of only two binary waves that are formed of a single substance, the wave medium. Traveling in opposite directions, the two waves are mirror images of each other. Many ancient philosophers, who carefully observed nature and deduced some of its properties, had predicted that nature is based on a single substance.

These binary elements or waves, are the bottom of an inverted pyramid of forms of matter. Layers of the pyramid increase in complexity beginning at the bottom with: a) the WSM, b) the atoms of the Mendeleev Atomic Table, c) the inorganic molecules which form the minerals and substances of the Earth, d) the complex organic molecules that are the building blocks of living things, and e) the very complex structures of life – plants, animals, and ourselves. The complexity of matter at the top of the pyramid is beyond mathematical description but we can, in principle, understand how to arrive there because of its simple binary basis. That so much information and apparent complex behavior can be the result of such a simple basic structure is amazing.

THE EVOLUTION OF LIFE.

Richard Dawkins in his best-seller book, *The Blind Watchmaker*, (1996) made pioneering steps to understand the evolution of life by examining its genetic basis according to the mathematics of probability. He finds that evolution is best explained by the existence of primitive *replicator* molecules that were able to duplicate their own structure. These were the precursors of the RNA-DNA molecules found in every living cell today. Critical to Darwinian evolution is the concept that not every theoretical mutated gene is actually probable. Dawkins finds that only the most probable paths are followed in the development of new genetic traits. The wave structure of matter provides a reason why this might occur: Only special, usually symmetrical, atomic and molecular structures occur frequently in nature; For examples, H, O, N, and C atoms, the six-carbon-atom benzene ring, the water molecule, and the hydrogen molecule are common structures. Knowing the WSM we can see that these common structures are a result of the *Minimum Amplitude Principle* of the WSM discussed above. If so, another chapter may be added to the search for the origin and meaning of life, using this new knowledge of the binary wave elements of matter.

NATURE IS A COMPUTER. Those of us who are intimately involved with computers and communication are often humbled when we realize that all the wonders of computer technology, the exciting color images on our monitors, the lightning-speed messages, the world wide web of information, and even love affairs, which began on the Internet, are only a stream of binary numbers! Just an electronic "dit-dah, dit-dit, dit-dah, dit dit". Just zeros and ones... nothing more! The thought that human love affairs may be electronic makes you smile. But this profound concept is well known; that simple systems can evolve into fantastic complexity. We can relate this to ourselves, as we humans are surely one of the most amazing, complex evolved structures. This remarkable concept is easier to understand if a stream of familiar decimal numbers is used to create the sounds and painted images on a screen. But it doesn't matter: binary or decimal, numbers are numbers. In any case, the contrast between the binary stream and the final display is awe-inspiring. We are amazed by this remarkable capability of mathematics.

MATHEMATICS AND LIFE. There is another view of mathematics that you can muse upon. A philosopher friend (GH) wrote this about the connection of mathematics with waves and space,

"I would turn this around and say the remarkable properties of space and its wave motions underlie the logic of mathematics. I now think logic can be generally defined as the necessary consequence of the language we are using (defined by principles), and when correctly applied then it is true. For example if I define $1+1=2$ and $1+1+1=3$ then it must also be true that $1+2=3$. Similarly, if I am older than Robert, and you are older than me, then you must also be older than Robert. This is a necessary consequence of our language. What we are doing in this study of nature, is creating a new language that describes reality based upon spherical waves flowing IN and OUT through their respective wave centers. This new simple language is required for a logical, true description of Nature, of our world, and how we exist in it, and sense this world."

Nature is also binary in its physical structure of matter and energy. Knowing the properties of mathematical binaries, and knowing that inward/outward waves are the structure of particles, we realize that Nature is a universe built with binary elements that are pairs of spherical quantum waves. The simplicity is humbling. Complicated messages, videos, sounds, and emotions are combinations of the inward and outward quantum waves that constitute the charged particles of matter. These two quantum waves are all that is necessary to construct protons and electrons, atoms that become molecules, which, in turn, compose the solid, liquid and gaseous matter of the universe.

And finally, after many billions of years, nature has evolved mathematical methods (The replicators of Richard Dawkins above) of making similar copies of complex wave systems (RNA-DNA organic molecules), which have led to life in the model of Darwinian Evolution. Thus living things, including you and me, are made of complex matter, that is, evolved large wave systems. But their basic elements are just simple wave centers formed by



pairs of spherical waves. Large wave combinations are held in stable arrangements by a well-known property of waves, that is, the ability of wave centers to combine their amplitudes, and arrange themselves to produce minimum total amplitude. This is seen in the familiar leveling of the water of a lake, or the flow of energy from hot to cold. Another result is that similar centers resonate with each other when they occupy the same space. If two waves have identical amplitudes, they reinforce each other. If two waves have opposite amplitudes, they cancel and the waves annihilate each other. This explains why charges attract or repel each other.

Waves are the origin of properties of minerals or wood, for example, to be 'hard'. A large number of wave centers are held rigidly together in minimum amplitude structures and hence take on geometrical properties: cubes, tetrahedrons, etc. that form crystals. The old particle models were at a loss to explain solid matter because there was no mechanism of the forces between them. It is now clear that the presence of the waves is the mechanism of force and solid structures are formed of combined waves, analogous to waves in a drum, a pipe, or other musical instrument.

It is this special property of resonance that leads to the atomic table of elements and the vast numbers of molecules that can be formed from them. Like binary numbers, the binary pairs of waves provide endless combinations to form different kinds of matter. Perhaps a more elegant and inspiring analogy is the comparison of Nature's quantum waves with musical notes. Music is also structured of simple waves that can be combined and resonated in a myriad of ways by a composer and an orchestra to produce vast numbers of melodies and compositions. Whimsically, this analogy might be interpreted to conclude that humans should live more harmoniously, than we do because we are a small part of the greatest orchestra that is Nature and the Cosmos. Our lives may have a goal of the harmony of the Spheres in a musical universe!

It is not difficult to see the binary universe in action if we look. We see the binary universe when we observe that there are only two kinds of electrical charge, that all particles have anti-particles, and that particle spin is either clockwise or counter-clockwise. The concept of anti-matter is just a form of matter that has opposite phases of the spherical waves of the particle resonances.

THE BALANCED HARMONY OF ENERGY. A basic physics calculation of the energy in any oscillator shows they have balanced kinetic energy forces and potential energy forces. This is why the motion of the oscillator is a sine wave, the result of balance between these two energies and forces. This fact underlies the structure of the oscillating wave pairs of matter. Thus energy and force balance are basic to all matter. If you wish, you can speculate upon the ancient wisdom of Eastern Mysticism, particularly Buddhism, that also has a foundation of balance and harmony, and a connectedness and perpetual change of all things. This is also seen in the balances of the Chinese yin and yang concept of life and the heat and cold concept of good health. How were these ancient philosophers able to deduce the structure of matter before quantum waves were even suspected? Clever people!

The business of physics is the abstract description and quantification of facts observed in nature. The rules we form for reconstruction and expression of the observed facts are the laws of nature and Principles of nature. Several centuries of experimental observation has turned up a half dozen mathematical rules and a dozen constant numbers that have become the discipline of physics. These rules are named the 'Natural Laws'. The laws can be combined mathematically in myriad ways to produce the disciplines of mechanics, electricity, chemistry, engineering, geology and other applied sciences. In this book we wish to find how the laws originated from the wave structure of matter.

Since past laws were obtained by measurement of nature rather than derived from other knowledge, they are by definition *empirical* and "of unknown origin". Therefore if we seek to find the origins of laws we cannot use the existing laws themselves but must use other observed facts together with logical deduction and established mathematics to find new principles. The classic method: that is propose a theory using the laws, and then do an experiment, does not work because we are seeking the origins of the laws themselves. The search for origins must probe deeper into nature than heretofore and we must be prepared to find unprecedented perspectives of nature. Accordingly in the search for the origins of natural laws, observations of unexplained puzzles, like quantum particles and in cosmology, are attractive places to begin. Finally, the proof of the origins of laws so deduced must be a match between the observed empirical rules and the origins derived from the wave structure of matter.

As explained above, when seeking origins, it is important not to inadvertently use the existing rules (laws) to deduce themselves. Such *circular reasoning* can occur if, for example, a mechanical toy model from macro-physics is assumed to be the structure of a quantum particle. In the same vein, the quantum rules of quantum particles can be extrapolated to large macro-objects, but the inverse is not possible. Logically, finding the origins of existing laws (rules) requires forming new concepts that nevertheless satisfy observed data. It is a major result of this book to deduce that the natural laws originate from the properties of the wave structure of the charged particles (electron, proton, etc), and the properties of space (ether, vacuum, and such terms), which form the totality of all particle quantum waves. The discovery of these origins creates a radical new picture of the physical world: quantum mechanics and relativity are united, origins of forces are understood, puzzles and paradoxes are explained and, most important, relationships between microphysics (electrons and particles) and the universe (cosmology) are seen to be a result of an all-pervading space (the vacuum or ether) filled with oscillating quantum particle waves. This is discussed further in the chapter on Origins of Laws.



SECTION II | HOW DOES MATTER 'HERE' DEPEND ON OTHER MATTER ELSEWHERE IN THE UNIVERSE?

This question involves the meaning of these words: particles, laws and Universe. We will see that the words are inherently inter-connected. To state that the universe exists makes demands on its content. Without particles to populate a universe, the universe could not exist because our concept of universe is a collection of particles and their distribution. Thus our understanding of our universe depends on our understanding of the particles in it. Further, the natural laws of the universe have no meaning without particles; because laws demand the presence of particles, upon which the laws can operate. Particles without laws are meaningless because particles are defined by the laws that identify them. In order to relate the laws to Nature, we need to understand their relationship to the electron and proton, the two 'particles' whose infinite waves dominate the Universe. Thus our perception of particles and the Universe depends on the form of the natural laws.

These three, *particles*, *laws*, and the *Universe* are an interdependent *trilogy*. Each requires the existence of the others. Therefore, we cannot expect to understand cosmology, the structure of the universe, unless we also understand the relationships within the trilogy. The relationships between separated particles of matter are brought out by the following discussions of the natural laws (rules of Nature). Newton, Leibnitz, Lorentz, Schrödinger, and Mach asked and discussed many of the arguments given below and deduced many properties that the rules, forces and particles must have. One such property is known as Mach's Principle that asserts that inertia is a result of an inertial reference frame established by all matter in the universe. I will say more about this later.

WHAT IS SPACE? Space is something that we don't ordinarily observe in our casual life. It needs a special explanation. You can deduce that something must exist if you look about you, and sense the three-dimensional (spherical) space around you in which we all exist. Your senses are correct. Science depends upon this space and its properties as the one foundation for all our experiences of the Universe. If space exists then it must have properties – first as a wave medium. Consider the role of waves in a substance like a diamond. A diamond is solid to our senses – a property of the waves in space. We can't see the space, but we can sense the spherical waves flowing through the space that form the wave centers that are the carbon atoms of the diamond. So we deduce the space must be there as a very rigid medium of the waves that produce the regular spacing of the carbon atoms. In contrast, the old discrete particle concept cannot explain how the carbon atoms appear suspended, unconnected, in a regular crystal array. There are no waves, no space, and no medium – just a puzzle.

DARWINIAN SURVIVAL AFFECTS OUR PERSPECTIVE

We don't easily see the space medium. In our self-focused human perspective few of us are even aware of the wave medium in which we exist. Traditional



science has tended to comprehend the universe in terms of our own local experiences. For example, old science has assumed that matter particles are like tiny grains of sand. But only a few people like Einstein saw that grains were impossible or ever asked how the grains communicate forces – unexplained by the old physics. Forces were ‘magic’ or ‘faith’, depending on your scientific taste. If you abandon the logic of science, you can attribute forces to Druids or the gods of Valhalla or Hades depending on your philosophical taste. The WSM in cosmological space removes this confusion.

Human survival has another bias. We tend to see space as three rectangular dimensions, one of which is the vertical gravity vector of Earth, plus two other vectors perpendicular to it, shaped like the earthly houses that protect us. We tend to prefer 3D as a coordinate system. Recognizing this bias, we realize the true shape of the enormous Universe is spherical whose important dimensions are inward and outward, the directions of waves in space.

PRINCIPLES OF NATURE

SECTION III NATURE'S MATHEMATICAL BASIS OF WAVE STRUCTURE

The mathematics of the electron and the origin of the natural laws can be obtained from only three Principles that underlie the Quantum Wave Structure of Matter. Nothing else is needed. These are:

- 1) **The Wave Equation of scalar (quantum) waves.**
- 2) **A Wave Density Principle that determines how the medium is formed.**
- 3) **A Minimum Amplitude Principle (MAP) that describes the behavior of waves.**

It is possible to obtain the third from the second, so actually only two principles are enough, but without MAP, math is abstract. These three principles are the paint on the palette that Nature uses to conceive, design, and build the material universe.

MAP: OR THE MINIMUM AMPLITUDE PRINCIPLE III. If you would like to see how the third principle III is obtained from Principle II, use the following description of over-lapping wave behavior. Imagine two electrons or spherical wave systems a few centimeters apart. Call them A and B. Since waves near their wave center have a higher wave amplitude, the in-waves of A will have a lower amplitude than the central in- or out-waves of B. Hence the high amplitude waves of B over-lapped with the low amplitude wave of A, increase the density of the background space – according to Principle II. Thus the high amplitude waves of B have a greater velocity, and will catch up to the slower, low amplitude in-wave of A. The result is that the waves will move together until their velocities become equal, so they will stay together. Accordingly the waves have balanced and minimized their wave amplitudes. This is the MAP principle III.

In general, a non-uniform medium will cause a change in shape of a spherical wave system making it ellipsoidal, so that the system's inwaves will continuously converge to new locations for the wave center. We will observe



this as motion or an acceleration of the wave-center (the particle). This motion will decrease the non-uniformity of the medium; again the role of MAP.

In Einstein's General Relativity, space is described in spherical/ellipsoidal geometry. A non-uniform wave medium is treated as the curvature of a four dimensional Minkowski space. This is a more detailed, abstract and mathematical description of space, the wave medium but it is equivalent to the WSM.

THE APPEARANCE OF A POINT PARTICLE. The interactions we observe for 'particles' occur mostly near to each wave center, where the wave amplitude is very high. This is why we tend to see the wave centers as resembling 'points'. Keep in mind that most of the wave amplitude, even though it extends to infinity, is inside a radius of 10^{-12} meters – rather small on the human scale.

A CAULDRON OF WAVES. When an outgoing wave encounters other particles, their out-waves are joined with part of the initial out-wave. These out-waves arrive in phase at the initial center. Thus the out-waves from all the other particles form a Huygens Combination wave front that is the in-wave of the initial particle. This occurs throughout the universe so that each particle depends on all others to create its in-wave. We see it is wrong to imagine each particle as one pair of in- and out-waves, because one pair cannot exist alone. We have to think of each particle as inextricably joined with other matter of the universe. Although particle-centers are widely separated, they are one unified structure.

The philosophical conclusions are fascinating. The connectedness of the universe asserts: *Everything we are and observe here on Earth, matter-laws-life, necessarily depends on the existence of all the matter in the universe.* We must conclude, if the stars and galaxies were not in the heavens, we could not exist! Thus, we are part of the universe, and the universe is part of us.

BUDDHISM WITHIN THE WAVE STRUCTURE OF MATTER. It is not the purpose of this book to investigate the existence of intelligence or religion in the Wave Structure of Matter. Nevertheless, many scholars of consciousness have noted them. One of the them, Yasuhiko Genku Kimura, philosopher and Editor-in-Chief of the journal VIA, comments below

Today, science habitually views the universe structurally. The paradigm of Western mode thinking and conceptualization is structure-oriented, and the Western languages are noun-based, unlike Tibetan or Japanese which is verb-based and process-oriented. Thus, the process-oriented Eastern mind can understand and appreciate the Wave Structure of Matter (WSM) more easily or readily than the structure-oriented Western mind, which now dominates the world.

Because of the Western mind's structure orientation, the universe is seen as an aggregate of particles (entities) while Divinity or God is seen as some sort of a supreme entity. Thus, the notions such as the discrete particles, the discontinuity of motion, the wave-particle duality, and the Big-Bang that are propounded in physics and cosmology are paradigmatically believed to be true. Many people believe that the Big-Bang is a fact and that the quantum

world defies rational or logical comprehension, both of which beliefs are proven or shown to be false in the light of WSM.

Now, according to the most advanced form of Buddhism, Dzogs-chen (pronounced "zog-chen"), the fundamental matter or "stuff" of the universe has three basic attributes: *openness* (in the sense of ceaseless opening), *resonance* (which is excitatory intelligence), and *radiance* (in the sense of the primordial light, which lights-up the phenomenal universe. The English word "phenomenon" comes from a Greek root, meaning "light-up.")

According to this view, the universe is eternal and infinite, having no beginning (in time) or no end (in space). The Space, which is the primordial "stuff" of the Universe and is essentially the Universe itself, is imbued with Light which unceasingly lights-up to engender the phenomenal realm and with Resonance which is Ecstatic Intensity constituting Excitatory Intelligence which evolves in complexity. Unlike a structure-oriented view, there is no what or who that perturbs the space, because Space is all there is and it has resonance or perturbation as its essential nature nor is there any intelligence, consciousness, or freewill outside the space but Space itself is primordially conscious and intelligent.

The ancient Chinese Taoists identified a set of logic operatives in the universe, namely the yang (yes/inward vector), the yin (no/outward vector), and the unnamed or the jien in *Tai H'suang Ching* (maybe/turn-round pause between two vectors). The reason I-Ching uses the binary logic is because it is concerned with the phenomenal universe which is the result of lighting-up after the freewill/creative choice has been made. Therefore, the phenomenal universe is based on binary logic (of yes or no) and process (of inward or outward vector).

When we combine these two Buddhist and Taoist view with the concept of the Great Chain of Being of perennial philosophy of the East and West such as Plotinus' view, we will get a quite comprehensive view of the universe totally consistent with WSM.

The question is how we can know the validity of these esoteric views? Milo Wolff uses the scientific method of knowing which is conjecture. The same applies to all legitimate scientific investigators. However, the Buddhists, Taoists, and others use a different method of knowing from conjecture in their investigation. This method is commonly known as meditation, which is the method of knowing in which the self (consciousness) become conscious of consciousness itself without objectifying it. As a scientist must develop skills in the art of scientific investigation, one must develop skills in the method of meditation, for without mastering the art of meditation, one can never understand what the Buddha knew.



CHAPTER FIVE

ORIGINS OF THE NATURAL LAWS FROM THE WAVE STRUCTURE OF MATTER

I. The Meaning of the Natural Laws

II. The Origin of the Natural Laws

"A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it."

– Max Planck



INTRODUCTION. The purpose of the chapter is to show how the Natural Laws originate from the Wave Structure of Matter. Before the WSM, all laws were derived from experimental measurements and the resulting empirical equations were used to describe the measurements. Now we can have both understanding and the mathematical origins.

Philosophers have often sought the origin of Natural laws in a relationship between the microscopic world and the vast universe. Until recently, before large telescopes and technology were capable of deep-space investigation, there was no knowledge to support such inquiries of Nature. We did not know where natural laws come from or even that it was possible to find out. Some scientists believed, in a religious fashion, that we were not allowed to know, that we must just accept the laws given to us by Nature. Still others had believed that the natural laws were already complete and to obtain further understanding all we need do is mathematically manipulate them to discover their origins.

Understanding began because curious scientists such as Clifford, Einstein and Schrödinger had noticed that all is not well with the empirical laws of nature. In small ways they failed to predict. In addition, the ancient concept of Democritus, that particles are "points of substance" was in direct conflict with both the new wave mechanics and experimental observation. Until recently, we didn't understand inertia, or whether a particulate "photon" can exist, or how "spin" can arise in a spherically symmetric particle.

Before looking at the details of the origins of the natural laws, it is inspiring to think about the role of the mathematical natural laws and how some scientists think about them.

THE POWER OF UNDERSTANDING IN EQUATIONS. Great equations share with fine poetry an extraordinary power. Poetry is the most concise and highly charged form of language, just as equations are the most succinct form of understanding of the physical reality that they describe. For example, $E = mc^2$ is itself enormously powerful: its symbols encapsulate knowledge that can be applied to every energy conversion, from ones in every cell of every living thing on Earth, to the most distant cosmic explosion. Better yet, it seems to have held good since the beginning of time. The WSM tells us why.

Great equations are just as rich a stimulus to the imagination as is poetry. Shakespeare could no more have foreseen the multiple meanings that readers have perceived in "Shall I compare thee to a summer's day?" than Einstein could have predicted the myriad consequences of his equations of relativity. None of this is to imply that poetry and scientific equations are the same. Every poem is written in a particular language and loses its magic in translation, whereas an equation is expressed in the universal language of mathematics: $E = mc^2$ is the same in English as it is in Urdu. But there are differences; poets seek multiple meanings and interactions between words and thoughts, whereas scientists intend their equations to convey a single, logical meaning.



WHAT IS A LAW OF NATURE? The natural laws describe natural behavior and are usually expressed as equations. Before the WSM, each law was a mathematical copy of measurements of Nature; thus it was an empirical law. An analogy popularized by the physicist Richard Feynman helps to clarify this relationship between equations and empirical laws. Imagine people watching a game of chess. If they had never been taught the rules of chess, they could work them out simply by observing how the players moved the various pieces. Now imagine that the players are not playing ordinary chess, but are moving the pieces according to a much more complicated set of rules on a hugely extended board. For the observers to be able to work out the rules of the game, they would have to watch parts of it extremely carefully, looking for patterns and any other clues they could muster. That, in essence, was the predicament of scientists before the WSM. They closely observed nature - the movements of the pieces - and tried to glean the underlying laws.

It is difficult to understand Nature beyond the empirical laws even though they can be written down conveniently as equations. But some laws, like the WSM, are not empirical because they directly describe Nature itself. In physics, Einstein's equation of general relativity gives a new meaning to gravity by equating the curvature of space to the energy density of matter at that location. Then the curvature produces the gravity force. In quantum theory, Schrödinger's equation describes the behavior of matter in the micro-world as waves, enabling an understanding of atoms and molecules that had proved impossible with older ideas. John Nash, the Nobel prize-winning mathematician who suffered from schizophrenia and is the subject of the film *A Beautiful Mind*, came up with equations that determined how two people ought to behave in competitive games. Economists and biologists later found that his ideas were extremely relevant to their work.

THE GOD OF NATURE IS A MATHEMATICIAN? Why is it that so many laws can be expressed as an absolute equation; i.e. that two different quantities (the equation's left and right sides) are exactly equal? Why do fundamental laws exist at all? A popular, tongue-in-cheek explanation is that God is a mathematician, an idea that unhelpfully replaces profound questions with an unverifiable proposition.

The Indian-American astrophysicist Subrahmanyan Chandrasekhar probably spoke for most great theoreticians when he remarked that when he found some new fact or insight, it appeared to him to be something "that had always been there and that I had chanced to pick up". According to this view, the equations that underlie the workings of the universe are in some sense already "out there", independent of human existence, so that scientists are cosmic archaeologists, trying to unearth laws that have lain hidden since time began.

Of the hundreds of thousands of research scientists who have ever lived, very few have an important equation to their name. Two scientists who were adept at discovering fundamental equations and also perceptive about the role of mathematics in science, were Albert Einstein and the brilliant theoretical physicist Paul Dirac. Both were remarkable in their ability to



find new equations that were as fecund as the greatest poetry. And both were captivated by the belief that the fundamental equations of physics must be beautiful.

WHAT IS MATHEMATICAL BEAUTY? This may sound strange. Yet beauty is a word that readily comes to all of us when we are moved by the sight of a smiling baby, a mountain vista, an exquisite orchid. What does it mean to say that an equation is beautiful? Fundamentally, it means that the equation can evoke the same rapture as other things that we describe as beautiful. Like a great work of art, a beautiful equation has among its attributes more than mere attractiveness - it has universality, simplicity, and elemental power. Think of masterpieces such as Cézanne's Apples and Pears, Buckminster Fuller's geodesic dome, Ella Fitzgerald's recording of Manhattan. They provide a presence of something monumental in conception, fundamentally pure and crafted so carefully that its power would be diminished if anything in it were changed.

An additional quality of a scientific equation is that it has utilitarian beauty. It must tally with every relevant experiment and make predictions of future experiments. This aspect is akin to the beauty of a classic Swiss clock or watch that is so well made and accurate that collectors love them and enjoy watching their movement.

The concept of beauty was especially important to Einstein. According to his son Hans, "He had a character more like that of an artist than of a scientist as we usually think of them. For instance, the highest praise for a good theory was not that it was correct or exact, but that it was beautiful." He once went so far as to say that "the only physical theories that we are willing to accept are the beautiful ones", taking it for granted that a good theory must agree with experiment.

Dirac was even more emphatic than Einstein in his belief in mathematical beauty as a criterion for the quality of theories. In the latter part of his career, he spent much time touring the world, giving lectures on the origins of the equation that bears his name, stressing that the pursuit of beauty had always been a lodestar as well as an inspiration. During a seminar in Moscow in 1955, when asked to summarize his philosophy of physics, he wrote on the blackboard in capital letters, "Physical laws should have mathematical beauty."

SECTION II THE ORIGIN OF THE NATURAL LAWS

The remarkable beauty of the WSM is that it contains all of the natural laws from Newton (gravity and inertia) to Einstein (Special and General Relativity). This is not the result of an encyclopedic character but simply because the Natural Laws are themselves properties of the waves that constitute the matter of the Universe; And the waves in turn are properties of one thing, the wave medium of space. Thus to find the origins one need only look at the wave structures that are embedded in the space quantum medium of the Universe. Accordingly, having a single basis, Nature could not be more simple. The greatest simplicity has the greatest beauty.



PREVIOUS EMPIRICAL NATURAL LAWS. Our previous knowledge of science and technology was based on measured natural laws that describe the behavior of particles. These laws are the rules for calculating electricity, gravity, Special and General relativity, quantum mechanics, and conservation of energy and momentum. Since these past laws were obtained only by measurement of nature rather than derived from knowledge of Nature, they are by definition empirical and "of unknown origin". The Wave Structure of Matter is the actual origin of the natural laws.

For centuries, futile attempts have been made to find the origins of the laws using discrete particles. But this was hopeless because the laws are embedded in the properties of waves. In the era of the discrete particle, it was common to mistakenly attempt circular reasoning. For example, mechanical models from macro-physics were proposed to find the structure of an electron. Such common errors were the use of toy tops, sheets and rings of charge, and planets in orbits. But this was impossible; one cannot use a discrete electron as a structural element to find itself.

PROOF THAT THE WAVE STRUCTURE OF MATTER DESCRIBES THE TRUE NATURE.

Knowing the origins of the laws has a subtle philosophical value that is not immediately obvious. Many people ask, "How do I know the WSM is the correct description of Nature?" To answer, one must carefully understand the meanings of Nature and of Proof. Then a positive answer becomes clear.

Nature, as far as most scientists were concerned, was the sum total of all the empirical natural laws that have been observed and measured. Scientific Nature in the past was those laws expressed as equations. That is what we meant by Nature. Up to now, there have been no causes or sources identified that produce the laws. Experimental scientists simply found and accepted the measurements that were then cast into equations as best as possible. Along the way, they discovered that Nature seems to prefer simple mathematical relationships but they didn't know why. Nevertheless they marveled that many of the equations appear to be exact and wondered why Nature appeared to be a mathematician.

Thus to find a totally correct description of Nature is equivalent to finding the origin of all the empirically described laws. If a single origin can be found there is no simpler origin so that becomes proof that the correct description has been found. As mentioned earlier, quantum space is that single origin. Also a proof of a correct description is very demanding because it must include all the laws. If only one law is not found to be a result of the WSM, then the proof fails. This has not occurred; in fact, if as Clifford and Schrödinger deduced and proposed; that particles and laws are the appearance of the structure of space, there is no logical possibility that all the laws are not included.

In the past, in the era of physics where discrete particles were assumed to be the elements of matter, scientific proof was a different concept. From

time to time various claims were made for particular events or results related to a single law. No one ever claimed to have a proof of all the laws. Thus the standard demand of proof made on the claimant was to propose an experiment and if the measures obtained agreed with one or more laws, the claim was verified.

In the case of the WSM originating from a single unique quantum space, the concept of proof is different. Instead, a sufficient proof is finding a mathematically correct origin of all the Natural laws. There is no need or logic to propose special experiments. In fact, finding the origins of all the laws is the equivalent of all scientific measurements of laws ever made. This is the subtle philosophical meaning of the WSM proof.

FINDING THE ORIGINS OF LAWS. Logic tells us that one cannot use the existing laws themselves to find their origins but must use other observed facts of Nature, together with established mathematics. As predicted by Schrödinger and Clifford (See History chapter), all laws are properties of wave structures in the universal wave-medium of space. The old empirical laws are then a result of the WSM. A prose description of the origins of natural Laws from the WSM is given below. Additional mathematical descriptions are provided in the last chapters. Chapters 2 and 3 have already shown that all laws are based upon two Principles (I and II) of the properties of space together with a third Minimum Amplitude Principle III (MAP) that is actually a result of II. The proof of the correctness of the WSM is that the origins so found must match or improve upon the previous measurements of all the empirical laws. This is found to be true.

The following are qualitative descriptions of the origins, intended to provide the clearest understanding of Nature and its behavior. However the mathematical reader may also like to compare with mathematical versions in chapters 12 and 13.

A. ORIGIN OF CHARGE PROPERTIES.

The properties associated with 'charge', a property of an electron, derive from Principle I, a wave equation whose only solutions, are two spherical wave pairs that form resonances located around a wave-center. Remarkably these wave pairs contain the experimental properties of the electron and positron, as follows:

a) charge polarity: The wave-centers will move together or apart in order to minimize total amplitude according to MAP. Polarity depends on whether there is a + or - amplitude of the in-wave at the center. If two electrons are near one another, their identical waves add together producing maximum amplitude causing them to move apart seeking a minimum. If one is a positron, their waves will cancel each other producing a minimum amplitude that will be decreased as they move together. These changing amplitudes appear as forces dependent on total wave amplitude that changes with distance r as $1/r^2$ thus matching the usual empirical Coulomb law.



b) Annihilation: If a resonance (electron) is superimposed upon an anti-resonance (positron), they annihilate because the two wave sets are exactly opposite and sum to zero.

c) Spin: Previously, spin was a mystery because it is a property of waves only, not found in 'particulate models'. Spin occurs because of the rotation of the in-wave at the center to become an out-wave. Chapter 13 on Spin describes this and also shows how the famous Dirac Equation of spin is derived from wave rotation.

d) Finite charge potential at the center: Coulomb's classic law of charge says that force and electric potential of a charge are infinite at the center. This is never observed. Instead experiment shows a finite potential. The reason is seen in the amplitude equations of the Chapter 12 math of the Electron; exactly as observed. This is also shown in animated internet diagrams at:

<http://www.QuantumMatter.com/sec.html> and

<http://ryanhagan.net/mike/StandingWave3D/StandingWave3D.htm>

e) Inverse-square Forces between charges: The inverse square rule is a result of 3D space that causes wave amplitude to decrease as $1/r^2$. The charge force is a result of energy exchange near the wave-centers because space density is large there. See the Equation of the Cosmos in the Astronomy chapter.

B. ORIGIN OF INVERSION PROPERTIES – THE CPT RULES.

Richard Feynman created the famous Feynman Diagrams used to analyze experimental tracks of particles. Before the WSM, the origin of his diagrams was unknown and there was much speculation as to whether they were always true. This is because they involve waves and spin of the in and out -waves.

The diagrams describe properties of electrons that depend upon inverting (changing signs, + or -) of: time (**T**), charge (**C**) and parity (**P**) in the electron-positron amplitude equations of Chapters 2, 3, and 12 and the Spin chapter 13. You can find the rules yourself by experimenting with the equations as follows: to perform a Time inversion, change t to $-t$, which converts the positron into an electron. To perform a mirror inversion (Parity), imagine that the waves are viewed in a mirror. You will see that a positron is a mirror image of the electron. To change a particle to an anti-particle (Charge inversion), switch the in-waves and the out-waves, and the spin direction. This is shown in the Spin chapter. Feynman used an empirical-theoretical rule that successive **C**, **P**, and **T** inversions on a particle return it to the initial state. You can prove this **CPT** rule yourself by manipulating the equations and find that it is a property of the electron-positron wave structure. See the Spin chapter.

FEYNMAN'S TIME TRAVEL. The CPT relations are the basis of Feynman diagrams that describe the tracks of electrons and positrons in experimental labs. They were previously empirical, but now are a known result of their wave structure. Feynman only suspected this. You can now understand

Feynman's cryptic statement, "*A positron is an electron traveling backward in time.*" This statement led to many sci-fi films about time travel, but as the electron equations show, the positron does not actually go backwards; It is a perfectly normal citizen particle but its inward and outward waves are opposite to the electron, thus $+t$ in the electron is $-t$ in the positron.

We see that the space resonance displays all physical properties of an electron, viz: electric charge, forces, annihilation, spin, conversion to a positron, and CPT relations between Charge, Parity and Time. These are all described with equations of waves. To a scientist familiar with wave optics, the truth of the wave structure of an electron seems irrefutable. This is how waves behave.

C. DOPPLER ORIGIN OF QUANTUM MECHANICS AND SPECIAL RELATIVITY.

Quantum mechanics and special relativity were once thought unrelated. But the clue to their relationship is that they have one feature in common: Both laws depend on the relative velocity between two 'particles' that is two space resonances (SR). Using WSM, you can find the origins by asking, "What happens when two space resonances are in relative motion? That is, One SR may be thought of as a source interacting with another SR, as an absorber. By using the equations of the electron-positron with Doppler modified waves and relative velocity v , you find:

$$\text{Wave function received} = \Phi = \text{Doppler shifted}[\Phi_{\text{in}} + \Phi_{\text{out}}]$$

As a result of the Doppler, the in-waves Φ_{in} are red-shifted and the out-waves Φ_{out} are blue-shifted. The amplitude Φ received at each SR is the sum of Doppler-shifted in-and out-waves from the other. The results are remarkable: The Doppler alters the combined in- and out-waves so that each resonance sees the other with increased momentum and mass (rest frequency) by exactly the factor $[1 - (v/c)^2]^{-1/2}$ as in the math of Chapter 12. This is just the Special Relativity mass increase of moving particles. It is significant that both the in- and out-waves are equally involved; both are necessary and symmetrical.

The Doppler effect also causes the electron waves to be modulated with a deBroglie wavelength $L = h/mv = h/p$. Recalling that this is the experimental basis of *Quantum Mechanics*, we conclude that quantum mechanics is a fundamental property of the Doppler-shifted space resonance, also symmetrically dependent on both the in- and out-waves. The de Broglie wavelength leads to the Schrödinger Equation. This produces a new insight. In the discrete particle model it had long been thought that both in- and out- waves were only "probability waves". Now we see them as the real structure of the electron and as the origin of quantum theory itself.

D. ORIGIN OF RELATIVISTIC ENERGY. The above Doppler increase of frequency also causes an increase of mass m (i.e. frequency) so that $m = m_0[1 - v^2/c^2]^{-1/2}$ as seen by a moving observer. It also causes the



relativistic energy increase. Rearranging the mass increase above produces the relativistic energy equation:

$$E^2 = p^2 c^2 + m_0^2 c^4$$

Before the WSM, there had been no known physical reason for the theoretical mass increase of special relativity. Likewise there were no physical explanations for quantum theory or spin. Were these separate laws connected or not? Indeed, many theorists proclaimed that these phenomena were irreconcilable! Few thought about a connection because most physicists were satisfied with the discrete particle. After all, discrete particles had been in the textbooks for decades. But now we simply see the WSM contains their simple physical connection: i.e. QM and Special Relativity are both Doppler effects due to their relative velocity.

E. ORIGIN OF ENERGY TRANSFER. An important property of Nature is the mechanism of energy transfer. Experience tells us that energy transfer is essential for communication or acquisition of knowledge of any kind. Storage of information, whether in a computer disk or in our brain, always requires an energy transfer. Energy is required to move a needle, to magnetize a tape, to stimulate a neuron. There are no exceptions. This rule of nature is embedded in biology and our instruments. Knowing the energy transfer mechanism between particles is essential to understanding the natural laws. For details of energy transfer, See the chapter on Energy.

Even though Einstein had originally proposed the 'photon' he knew he did not know the cause of discrete energy exchanges of light. (See Einstein's 'Ideas and Opinions', 1954). In hindsight, he was correct about the futility of field theory based upon discrete particles but his later General Relativity Theory is now a true result of the WSM. Using the WSM the photon is now seen to be the observation of a wave-like energy transfer between wave centers. This is discussed in detail in the Energy chapter.

F. ORIGIN OF THE CONSERVATION OF ENERGY. The mechanism of energy transfer between atoms and molecules occurs where the density of space is high - at resonance wave-centers. This provides coupling and permits shifts of wave frequency. When the waves of a potential source and a potential receiver pass through each other's centers, and if an allowed resonant transition exists between them, MAP Principle minimizes the total of both amplitudes by choosing the transition. In the source, the frequency (energy) of the wave state shifts downward. In the receiver, there is an equal shift upward. Only wave states (oscillators) with equal frequencies 'tuned' to each other can couple and shift frequency. Accordingly, the frequency (energy) changes must be equal and opposite. This is exactly the content of the **Conservation of Energy** law. Resonant energy transfer is not too different from tuning up an orchestra matched to the first violin playing 'A'. Each instrument is adjusted to resonate with the first violin. This process also fulfills the proposal suggested by Einstein in the writing of Tetrode (1922): When I see a star 100

light-years away, the star knew that its light would enter my eye 100 year ago—before I was born! Tetraode was predicting that energy exchange is a two-way symmetrical resonance between source and receiver — not a one-way photon.

G. ORIGIN OF GRAVITY AND THE CAUSE OF PARTICLE MOTION. Gravity is a wave property of the in-waves of matter. To understand the gravity mechanism, first note that the in-waves of a particle, on arrival at the wave-center, determine the position and motion of the wave-center, the 'particle' we observe. Since any matter nearby like the Sun, will slightly increase the nearby medium density, this will proportionately increase the in-wave speed causing the waves to arrive earlier, changing the position of the particle center. This motion is interpreted by us as the force of gravity. In short, gravity is a result of the additional density of the wave medium around the attracting body. There are no 'graviton' exchanges. We now understand previous puzzles of gravitation using discrete particles because gravity is a pure wave phenomenon.

QUESTION FOR THOUGHT: THE READER MIGHT LIKE TO ASK HIMSELF WHETHER OTHER FORCES IN NATURE ALSO PRODUCE MOTION BY AFFECTING THE WAVE-CENTER'S POSITION IN A SIMILAR WAY?

G. ORIGIN OF THE INSTANTANEOUS ACTION PUZZLE. The great simplicity of the WSM can be appreciated by reviewing two former problems of gravity. One problem arose because astronomers have to assume, in order to match actual planetary motion, that all gravitational interactions between bodies are instantaneous: Astronomers have to calculate orbits using instantaneous forces; then find the position of a body along its orbit and calculate where that position would appear as seen from Earth using the speed of light from there to here. It seems illogical yet that is the required procedure to get the correct answers. This seems unacceptable because it is "action at a distance". Sir Isaac Newton elegantly expressed the objection: *"That one body may act upon another at a distance through a vacuum, without the mediation of any thing else, by and through which their action and force may be conveyed from one to the other, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking, can ever fall into it."* In other words, propagation at infinite speeds would require infinite energy. So instantaneous gravity seemed magical. This is also discussed in the book *Gravitation* by Misner, Thorne and Wheeler (1973).

There is a second dilemma: if you introduce a delay into gravitational interactions to compute orbits, the conservation of angular momentum is destroyed. Sir Arthur Eddington (1920) expressed this: *"If the Sun attracts Jupiter towards its present position, and Jupiter attracts the Sun towards its present position, the two forces are in the same line and balance. But if the Sun attracts Jupiter toward its previous position, and Jupiter attracts the Sun towards its previous position, when the force of attraction started out to cross the gulf, then the two forces give a couple. This couple will tend to increase the angular momen-*



tum of the system, and, acting cumulatively, will soon cause an appreciable change of period disagreeing with observations, if the speed is at all comparable with that of light." The same dilemma comes up in other guises: Why do total eclipses of the Sun by the Moon reach maximum eclipse about 40 seconds before the Sun and Moon's gravitational forces align? These dilemmas are created by the assumption of the discrete particle model.

But there are no dilemmas of gravity in the WSM. Instead, each body interacts directly with its local space medium whose density depends on nearby objects as well as on the matter of the Universe. Accordingly, gravity is a local energy exchange with the surrounding wave medium. Instantaneous action-at-a-distance does not occur. But the energy, exchanged locally, properly appears like "action at a distance", unlike the exchanges which propagate at velocity c . Thus Newton's original view of inertia and gravity is upheld. Newton simply was not aware of the intermediate wave medium – space.

H. ORIGIN OF THE GENERAL THEORY OF RELATIVITY (GTR). Einstein's theory describes the geometric properties of cosmological space and how matter behaves in it. The space medium of the WSM and the cosmological space of GTR are essentially identical. GTR explains these features by suggesting that gravitation (unlike electromagnetic forces) is a pure geometric effect of curved space-time, not a force of nature that propagates. Curved space is equivalent to the varying density of space in the WSM.

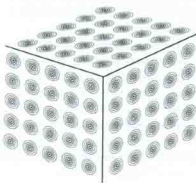
Note that in both GTR and WSM the properties of space are determined by Principle II that calculates the distribution of all matter in the Universe. And in both, the behavior of matter is determined by the space medium; termed space-time in the GTR and quantum space in the WSM. These two inverse properties form a fascinating reciprocity, or feedback, between space and matter. It has been expressed by Wheeler, *matter tells space what it is and space tells matter how to behave.*



Figure 5.1.

Atoms in a crystal. The waves of the electrons in the crystal array produce standing waves along the planes of symmetry. There is no solid structure, substance or material in the crystal. It is the waves traveling in the space medium that produce the array dimensions, and it is the immense energy density of the space medium that gives it physical strength and rigidity

QUESTION FOR THOUGHT: WHAT IS THE ORIGIN OF THIS REMARKABLE FEEDBACK BETWEEN MATTER AND SPACE? IT OCCURS IDENTICALLY IN BOTH THE WSM AND GTR (AS IT MUST) AND IS A PROPERTY OF SPACE. THE READER MAY BE CURIOUS TO FIND OUT. THE AUTHOR IS CURIOUS TOO!



Atoms in a Crystal

I. ORIGIN OF SOLID MATTER. The solid structures of everyday life are held together by wave structures that occur because of the Minimum Amplitude Principle that permits only solids with minimum total wave amplitudes. Solidity and rigidity are properties of the waves – there is no solid substance. For example atoms in say a diamond, are held in a rigid lattice by standing electron waves in the space medium traveling throughout the carbon lattice to satisfy the MAP, as shown in Figure 5.1. The strength of solids depends on the forces that produce the waves; these depend on the energy density of space; that is. the wave medium. The minimum energy density of space can be estimated as the density of nuclear matter. It is more than 10^{46} MeV per cubic centimeter, astoundingly large. We have no sensation of its presence despite its existence all around us, because humans can only sense energy transfers not space itself. Learning how the space medium exists this way is a pioneering topic in science today.

J. ORIGIN OF MAGNETISM. Classical Maxwell Theory of moving charges is often in serious error because the approximation of the discrete particle is very poor at small dimensions and particulate currents do not have wave properties of interference. The currents obtained do not produce the calculated forces. Recently (2000) Carver Mead at CalTech produced the first industrial application of the WSM in his book "Collective Electrodynamics" [MIT Press]. He recognized that electrons and currents in tiny computer chips (Intel corp.) behave as coherent wave structures, based upon the experimental measurements of B.S. Deaver and W.M. Fairbank (1961). By recognizing the collective wave behavior of electrons in motion, he replaced Maxwell's magnetic equations with a new formalism using the magnetic vector potential A . He provided the microchip industry with a new tool to design microcircuits that operate at faster speeds.

PHILOSOPHICAL CONCLUSIONS.

Most persons are aware of our connection with the Sun as the source of practical energy and life on Earth. But there is much more than the Sun, the connectedness of laws and waves with the enormous amounts of all matter in the universe is also fundamental to our life because; All the natural laws we observe here on Earth depend on the existence of the matter elsewhere in the universe. Thus if the stars and galaxies were not in the heavens, we could not exist.

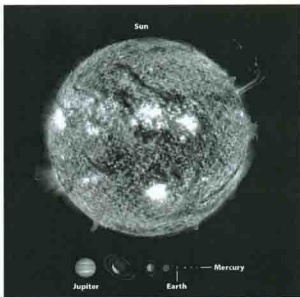
The conclusion that the natural laws and the appearance of matter here on Earth depend on all matter elsewhere in the Universe can be more easily appreciated by considering Figures 5.2 and 5.3.



SECTION II

Figure 5.2.

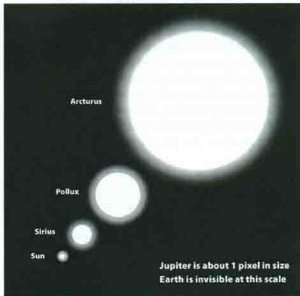
This scale drawing of the bodies in the Solar System shows how tiny is the Earth. Even the Sun is a small star in a huge galaxy of stars existing in a Universe of galaxies that is unimaginably larger. Do we consider ourselves and Earth too important?



5.2 Planet and sun images courtesy of NASA and the Space Telescope Science Institute

Figure 5.3.

Our Sun pales in size compared to three other well-known stars in the night sky. Our Earth is invisible at this scale. But this is still a small description. There are a billion, billion, billion other stars in the Hubble Universe! What logically determines the Natural Laws that describe the Universe?



The pioneers of physics; Ernst Mach, Erwin Schrödinger, William Clifford, Albert Einstein and others were all aware of the affect of the whole Universe in determining the origin of the Natural Laws as described in the conclusion above and as stated mathematically in Principle II of the WSM and in Einstein's General Theory of Relativity. This conclusion however is not yet part of the dogma of the science community at large mostly because of the ancient belief in the existence of discrete particles rather wave structures in space.

CHAPTER SIX

HISTORY OF THE SEARCH FOR THE WAVE STRUCTURE OF MATTER

- I. The Greek and Indian Philosophers
- II. The European philosopher-scientists:
Newton, Leibniz, and Galileo
- III. The Pioneer physicists: Clifford, Dirac,
Mach, Schrödinger, and Einstein
- IV: Maxwell's Electromagnetism:
Franklin, Lorentz, Maxwell
- V. The QM probability puzzle of Neils Bohr:
Wheeler and Feynman
- VI. Recent formulation of the Wave Structure of Matter:
Milo Wolff, Carver Meade, Aki Tonomura,
Geoff Haselhurst and others

*"Never doubt that a small group of thoughtful committed
people can change the world, indeed it is the only thing
that ever has."*

– Margaret Meade



SECTION I THE GREEK AND INDIAN PHILOSOPHERS

The origins of the Wave Structure of Matter were proposed in the late 19th - early 20th century by William Clifford and later by Erwin Schrödinger. However, this basis of Nature, that the Wave Structure of Matter in Space explains, is an ancient idea that dates back to the foundations of metaphysics; Ancient Indian Philosophy, and Greek Philosophy. Albert Einstein also realized that matter is spatially extended, agreeing with a concept of Ernst Mach. Recent mathematical development was done by Milo Wolff, by Geoff Haselhurst (philosophical foundations), and others.

TRUTH SEEKERS. Many people, from the old Greek philosophers such as Democritus (460-370 BC), Aristotle, and Pythagoras, up to modern astronomers sought to understand the structure of the tiny atoms and molecules of the objects in our everyday world.

Their logical search for the origin of matter and the natural laws had been a continuing pursuit of mankind for thousand of years. History shows that the first logical seekers were probably the Greeks and the Indian mystics. Even though lacking the research instruments of modern science, they made the remarkable deduction that all Nature must arise out of 'One Thing'. Their deduction was a result of observing that Nature was so varied in phenomena and locations that it was statistically impossible to have separate laws and mechanisms to account for everything. Therefore there must be only one cause or 'Thing'.

You the reader can deduce the same, if you have the time to think about it a while. You will also find, I hope, that one thing is a prediction of the Wave Structure of Matter because the wave-medium of space is the only single substance of the universe; accordingly all matter, objects and laws are its properties and therefore they are inter-connected. The mathematics of the electron reinforces this conclusion.

The famed Greek philosopher **Aristotle** (340BC) went one step further and added the concept that Nature had a principle of motion. He wrote: "*The first philosophy (Metaphysics) is universal and is exclusively concerned with primary substance. ... And here we will have the science to study that which is, both in its essence and in the properties which, just as a thing that is, it has. ... That among entities there must be some cause, which moves and combines things. ... There must then be a principle of such a kind that its substance is activity.*"

Similarly, in Indian philosophy, the words used by Hindus and Buddhists have dynamic connotations. They emphasize that the universe has to be grasped dynamically, as it moves, vibrates and dances. The Eastern mystics saw the universe as an inseparable web, whose interconnections are dynamic and not static. The cosmic web is alive; it moves and grows and changes continually. (Fritjof Capra, *The Tao of Physics*, 1972.)



A thousand years went by and not much was added to the Greek ideas until the flowering of the Renaissance in Europe, and the studies of Isaac Newton and Galileo Galilli who were concerned with physics rather than philosophy.

The origins of modern Natural Laws began in the sixteenth century with the work of the European astronomers and astrologers whose efforts resulted in the discovery of the law of gravity by Isaac Newton. His book "Principia" laid the groundwork for classical mechanics and engineering of the Industrial Revolution. It led to four fundamental laws: Gravity, Newton's Mechanics, Special Relativity and Conservation of Energy. Because of their economic and scientific importance, they have been elevated to almost divine status by the scientific community so that efforts to further understand them are seldom discussed – as if respect for Nature – the giver of laws – should not be questioned. Yet as logical scientists, we must be careful not to misinterpret Nature, to keep an open mind, and not assume more than is really there. Our reward will be a deduction of something new – the Wave Structure of Matter and the origins of the natural laws.

THE SCIENTIFIC ATTITUDES OF THE 1600'S. It should never be misconstrued that these brilliant men were striving to find scientific laws to be placed in your textbooks of 2006. Far from it! If you read their original writings you would quickly discover that Tycho Brahe was simply doing his appointed job of getting information that would predict the future and fortunes of his King using the art of astrology. Tycho believed in such magic and so did most of the intelligent men of his time. His goal was to be the best of the astrologer-astronomers and maintain the favors of the King. Kepler likewise believed in the existence of heaven, angels, and the teaching of the Church. Why not? Some of the best experts in the land were employed by the Church, so shouldn't they know!

Isaac Newton was a very neurotic man, which was probably the driving force behind his achievements. His deepest instincts were occult, esoteric and semantic and he probably anticipated obtaining magical powers from his work. He had a profound paranoid fear of exposing his thoughts, beliefs, and discoveries to the inspection and criticism of the world. The eventual publication of his works: *The Principia*, *Opticks*, etc. resulted from the extreme pressure of his friends, who recognized the value of his work to the world.

The Search for a Frame of Reference. In the seventeenth century, Isaac Newton thought deeply about the existence of an absolute scale in the universe to measure the location of material objects and their velocity and wrote, "Absolute motion is the translation of a body from one absolute place to another. Thus for a ship under sail the true and absolute motion of the body will arise, partly from the true motion of the Earth, in immovable space, partly from the relative motion of the ship on the Earth..."

Newton thus defined absolute location and motion but recognizing the impossibility of finding an absolute space, he added, "But because the parts of space cannot be seen or distinguished from one another by our senses,

therefore in their stead we use sensible measure of them. And so, instead of absolute places and motions we must use relative ones."

It is apparent that Newton's concern over relative and absolute location was well justified. Today there is no scientific means to find, or any logic to define an absolute space in the Universe. No object or group of objects can be regarded as a unique coordinate system enabling us to make measurements of position. Stars and galaxies have only motion relative to each other. Thus: The only possible reference for changing motion (acceleration or inertia) is the entire ensemble - all the matter of a universe. The first person to state this as a positive proposal (1893) was Ernst Mach (below).

A mathematician, **Gottfried Leibniz** (1670), the co-inventor of the calculus with Newton, also adopted the Greek ideas treating them in a mathematical way. He wrote: Reality cannot be found except in one single source, because of the interconnection of all things with one another. ... It is a good thing to proceed in order and to establish propositions (principles). This is the way to gain ground and to progress with certainty. ... I hold that the mark of a genuine idea is that its possibility can be proved, either 'a priori' by conceiving its cause or reason, or 'a posteriori' when experience teaches us that it is a fact in nature.

THE ORIGINS OF NATURAL LAWS. The business of physics is the abstract description and quantification of facts observed in nature. In laboratories we measure the properties of nature and attempt to deduce the rules she uses to organize the behavior of matter on the Earth; if we seek to find the origins of laws we cannot use the existing laws themselves but must use other observed facts together with logical deduction and established mathematics to find the origins. The old empirical laws are only a guide and not the source; we are on new ground. **Kant** first formalized this writing ('Critique of Pure Reason', 1781): *Natural science contains in itself synthetical judgments, a priori, as principles.* Accordingly the search for origins must probe deeper into Nature than heretofore and we must be prepared to find new perspectives.

Until recently, most answers concerning matter itself were speculations created in analogy to human scale objects around us; like baseballs and bullets, and grains of sand. Atoms were imagined to move like other familiar objects such as moons around planets and toy tops spinning on a table. These analogies made most scientists feel comfortable so they chose to ignore new ideas. As Churchill said, "*We often stumble onto the truth but most of us brush ourselves off and pretend it did not happen!*" Accordingly only a few persons (Einstein, Clifford and Schrödinger) looked beyond the discrete point particle.

THE QUEST FOR A THEORY OF EVERYTHING. An ancient scientific dream is to find a physical world based upon a single conception of the geometry of space. In recent decades, this hope had sprung anew in the brains of physicists, because of the partial success of Quantum electrodynamics (QED), which united quantum theory and electromagnetism and accurately explained the behavior of electrons and photons. These two theories were the sparkling gems of the 20th century: Quantum mechanics had partial success in explaining the wave-like

aspects of electrons surrounding atomic nuclei, and knowledge of electromagnetism has culminated in the astounding computer revolution. These achievements led some scientists to optimistically hope that the same methods could be applied to other particles and other forces and thus obtain a "Theory of Everything". Unfortunately most attempts began with the concept of an impossible discrete material particle.

Scientists were slow to accept new theories, especially if there are strange predictions or conflicts with long-standing ideas, which invite immediate skepticism. For several decades there have been many 'particle' proposals but no winners. As Freeman Dyson of Princeton said, *"The paths of physics are littered with the corpses of unified theories"*. For a physicist who believes that nature should be ultimately elegant and simple, this notion is the supreme challenge. All scientists realize that a true theory that condenses all of physics into a single concept will have profound consequences for science and its future.

As the years before 1990 rolled by without promise, the 'particle' attempts became increasingly bizarre: Multiple universes, microscopic strings, tiny tops, we live in a black hole, or a white hole, a universe made of worm-holes, the Big-Bang, and so on and on. Any incredible scheme, with any number of dimensions seemed to be a valid model of matter, provided the algebra was correct and it did not violate the conservation of energy. These solutions have been marked by complexity rather than simplicity. Many predicted that the solution to the deep puzzles would be strange. Niels Bohr commented, *"We all agree that your theory is crazy. The question which divides us is whether it is crazy enough."*

It is usually agreed, that any viable theory, however crazy, has to fulfill certain logical requirements. For example:

- 1) **It should not raise more questions than the answers it provides.**
- 2) **It cannot introduce more new constants than the natural constants it explains,**
- 3) **The number of assumptions required in the new theory should be much less than the properties of nature it reveals.**

But often the zeal to conform and publish overrules logic so eternal hope gives almost eternal life to many useless theories. As a wry philosopher observed, *"Truth is no match for belief."*

These independent and deep thinking men had the courage to leave the popular mainstream and deal with the facts behind the measurements of physics and astronomy. **William Clifford** the famous English geometer spoke [1870] before the Cambridge Philosophical Society saying: *All matter is simply undulations in the fabric of space*. His remarkable work was the progenitor of the WSM and General Relativity. In Clifford's concepts, the mass and charge substances that were assumed, do not exist but are properties of a wave structure in space. In short, space waves were real, while mass and charge points are mere appearances of the wave structure.

SECTION III

THE PIONEERS: CLIFFORD, MACH, EINSTEIN & SCHRÖDINGER



Erwin Schrödinger a co-discoverer of quantum mechanics and Nobel Laureate adopted the view of Clifford and sided with Einstein confronting the Bohr school that believed in probability functions for 'discrete particles'.

Nobel laureate Albert Einstein, adopted an extended-in-space concept of matter simply because he realized the point-particle model was impossible.

Paul Adrian Maurice Dirac was a mathematician who realized by calculation that converging and diverging spherical quantum waves fitted the experimental facts of 'particles' but he stayed on the sidelines of the quarrels with Bohr.

The proposals of these pioneers were both logical and consistent with present day quantum theory, since quantum mathematics does not depend on a belief in particle or charge substance.

THE WORK OF WILLIAM CLIFFORD. William Kingdon Clifford was a superb brilliant mathematician and astronomer; nearly a half-century before Einstein developed his general theory of relativity, and before even a hint existed of quantum mechanics. He discussed (1876) our ability to deduce the geometry of space at astronomical distances and in space too small (i.e. atom-sized) to be observed, stating: I hold:

- 1) That small portions of space are in fact analogous to little hills on a surface which is on the average flat, namely that the ordinary laws of geometry are not valid in them.
- 2) That this property of being curved or distorted is continually being passed on from one portion of space to another after the manner of a wave.
- 3) That this variation of the curvature of space is what really happens in that phenomenon which we call the motion of matter, whether ponderable or ethereal.
- 4) That in this physical world nothing else takes place but this variation subject to the law of continuity.

The interest of physicists in Clifford's mathematical work received a large boost some years ago when **John Archibald Wheeler** developed some of Clifford's ideas in his book *"Geometrodynamics"*.

Recognition of Clifford's work was inadequate. Einstein's discovery of General Relativity has been presented as the first successful attempt to describe physical space as non-Euclidean, ignoring Clifford. Unfortunately, Clifford's ideas were difficult to grasp in the 1870's. Einstein's version of curved space was not seen as radical in 1915 as Clifford's was in 1870. The rapid acceptance of relativity was made easier, by J.K.F. Gauss' measurements of space curvature from three mountaintops in Hanover in the 1820's. Gauss measurements were interpreted as a measure of space curvature long before relativity theory was introduced.

The fundamental element of space curvature in Clifford's mathematical model was the twist, which he planned to use to describe electromagnetic and atomic phenomena. But the complexity of the mathematics involved allowed only the best and brightest mathematicians to draw conclusions regarding the physics of space and time, directly from Clifford's mathematics.

Two generations separated Clifford's original work from general relativity. During that time, the popularity of the non-Euclidean geometries grew. When Einstein first completed and published his theory, it found an eager audience, which already accepted the possibility that physical phenomena could be affected by space curvature. Although many scholars added their own thoughts to this general attitude before the adoption of relativity theory, Clifford's contributions went beyond all others in both content and breadth of view that matter could be represented by space curvature.

Maxwell was completely against the non-Euclidean geometries. He was perplexed on 11 November 1874 when he wrote to his friend and fellow physicist Peter G. Tait, expressing his opinions, *The Riemannsche Idée is not mine. But the aim of the space-crumplers is to make its curvature uniform everywhere that is over the whole of space whether that whole is more or less than infinity. The direction of the curvature is not related to one of the $x y z$ more than another or to $-x -y -z$ so that as far as I understand we are once more on a pathless sea, starless, windless and poleless totus feres abque rotundus*. His reference to the "space-crumplers" indicates his disagreement with them, but also indicates that he could not ignore their arguments.

The year of 1873 marked a turning point in Clifford's quest for a space-theory of matter. Clifford published the essay "Preliminary Sketch on Biquaternions," which described a new calculus of twists and screws. The scientific community did not receive Clifford's new geometry very well. Clifford could not have known that his new geometry was far too advanced for a scientific community that was just beginning to cope with the discovery of ordinary non-Euclidean geometries. The more immediate concern of science was the development and understanding of Maxwell's theory of electromagnetism, and it was to that end that Clifford applied his biquaternions and twists.

CLIFFORD'S SPACE MODEL. At this point, Clifford's thoughts on "solving the universe" evolved in several directions at once, but his true passion was a description of matter in motion. To that end, he published what would prove to be his magnum opus, the *Elements of Dynamic* in 1878. The book accurately described what Clifford was trying to accomplish - referring to an elastic medium interpreted as the whole of curved space. Thus if the expansion and the spin are known at every point, the whole motion can be determined with the result that every continuous motion of an infinite body can be built up of squirts and vortices.

The second volume of the *Elements* was unfinished at Clifford's death. Some hints were given in the reconstruction of Clifford's book of the direction he hoped to take physical theory. For example, he related gravitation to



a strain in space. The model of space upon which Clifford settled could be briefly described as a four-dimensional elliptic space. The constant of curvature was too small for detection through astronomical observations, but that fact did not negate the possibility that space could be other than Euclidean.

The infinitesimal scale (future quantum theory) of nature presented other problems. On this scale the connections of contiguous points of space exhibited curvature in the fourth dimension. The three-dimensional analogue of this curvature was an elastic medium in which twists (future spin) were the most fundamental element. The twists, in turn, composed vortices and squirts that supplied strains in the elastic medium which gave rise to electromagnetic and gravitational forces.

NOBEL LAUREATE ERWIN SCHRÖDINGER. Like Einstein and Clifford he recognized that discrete 'point particles' were impossible. He wrote that the puzzle of matter will be found in the structure of space, not in point-like bits of matter, and that the physical world is based upon geometry of space. During discussions with Neils Bohr concerning the probability interpretation of his own Schrödinger's Equation, he firmly disagreed with Bohr and mainstream quantum mechanics and wrote: "*Let me say at the outset, that in this discourse, I am opposing not a few special statements of quantum mechanics held today (1950s), I am opposing as it were the whole of it. I am opposing its basic views that have been shaped 25 years ago, when Max Born put forward his probability interpretation, which was accepted by almost everybody. ... I don't like it, and I'm sorry I ever had anything to do with it.*" (Erwin Schrödinger, *Life and Thought*, Cambridge U. Press, 1989).

Schrödinger understood the requirements of particle structure when he wrote in 1937: *What we observe as material bodies and forces are nothing but shapes and variations in the structure of space. Particles are just schaumkommen (appearances).* He believed that quantum waves were real, not probability distributions with a particle hidden inside. He saw that abolishing the discrete point particle would remove the paradoxes of 'wave-particle duality' and the 'collapse of the wave function'. But his thinking was ignored for sixty years. Truth is no match for belief! Machiavelli understood this human behavior 500 years ago [1513] writing: *There is nothing more difficult to plan, more doubtful of success, more dangerous to manage than the creation of a new system. The innovator has the enmity of all who profit by the preservation of the old system and only lukewarm defenders by those who would gain by the new system.*

PAUL ADRIANNE MAURICE DIRAC. Dirac received a Nobel Prize for his work (1923) predicting the spin of the electron and the existence of the positron. At the time he did not realize that he was describing a quantum wave electron because his work was purely mathematical and not yet related to experiments that came later. Dirac had developed much of the theory describing the quantum waves of the electron, but was never satisfied with its point-particle character because the Coulomb electron required a mathemati-

cal correction termed "renormalization". In 1937, he wrote, "This is just not sensible mathematics. Sensible mathematics involves neglecting a quantity when it turns out to be small — not neglecting it because it is infinitely large and you do not want it!" Like Schrödinger, he had confidence in what his mathematics was telling him and refused to go along with the speculations and approximations of mainstream science.

BATTEY-PRATT AND RACEY (1980). They studied the properties of rotation of an electron or an atom and found, using the mathematics of group theory, that "spherical rotation" (See Misner, Thorne and Wheeler, 1973) of a structure in space produces the *spin* of an electron. They obtained the equation that Dirac had used to predict spin and the positron but did not go further and seek the physical origin of spin — a task left for the WSM of this book. Their little noticed breakthrough importantly meant that an all-wave structure of an electron could provide an explanation of the spin paradox and keep spherical symmetry. It was a simple next step for Wolff to realize that spin was the necessary mechanism for in-waves to change to out-waves. *[Note: Some ten years ago, I phoned to Battey-Pratt to tell him of the breakthrough he had pioneered. But he was no longer interested in mathematics! He was enthusiastically translating middle-eastern religious documents!]*

ERNST MACH (1838-1916) AND BISHOP BERKELEY (1685-1753). They proposed that the law of inertia depended on all the matter of the universe. This is known as *Mach's Principle*. It was the first recognition that a natural law depends on cosmology. Many had sought to discover where Newton's law of inertia, $F=dp/dt=ma$, comes from; what are its causes and its connections with other laws. Let's try to see the problem. How do we measure the rotational inertia? We must measure rotation using the so-called "fixed stars" and assume that the stars are at rest. That is, the stars determine the absolute reference frame of rotary motion. There is no other way to find the rotation!

It is very strange and mysterious that the stars, so far away through empty space, seem to dictate the operation of the most basic law of the Universe. The Austrian physicist-philosopher named Ernst Mach (1838-1916) first noticed and wrote about this. But before the Wave Structure of Matter, no one had gone beyond his speculative idea that the distant matter of the universe determines this law of inertia.

Albert Einstein was greatly influenced by it when he deduced both Special Relativity and the General Theory of Relativity (GTR). Now, Mach's Principle, in a more exacting form, has become Principle II of the Wave Structure of Matter in this book.

Ernst Mach had boldly suggested that inertia depends upon the existence of the distant stars. His concept arose from two fundamentally different methods of measuring the speed of rotation. First, without looking at the sky, one can measure the centrifugal force on a mass m and use Newton's Law in the form $F=mv^2/r$ to find circumferential speed v . The second method compares the object's angular positions with the fixed (distant) stars. Mysteriously, both methods give exactly the same result. Mach reasoned that there must

be a causal connection between the distant matter in the universe and inertia. He asserted: Every local inertial frame is determined by the composite matter of the universe.

Mach's Principle of Inertia is the clearest evidence to all of us, that very distant bodies can affect us apparently instantaneously. **Tom Phipps** rephrases Mach, "When the railway jerks, it is the fixed stars that throw you down." Mach's Principle was criticized because it appears to violate causality: "Events cannot occur before the causes which produce them." But this violation does not actually occur. Instead Mach's Principle being equivalent to Principle II of the WSM suggests that inertia is an interaction with the universal space-medium, not with the distant bodies. Because the universal medium is established by the distant matter of the Universe, it is around us at all times. This explains why the distant bodies appear to create inertia without a causality violation.

EINSTEIN'S SPECIAL THEORY OF RELATIVITY (1905)

Few things in science have a worse reputation for complexity than this theory, but it is totally undeserved. Relativity can be obtained from either of two experimental observations:

- 1) All observers, moving with respect to each other, always obtain the same measurement of the velocity of light, c , a constant.
- 2) A measurement of mass depends on the velocity of the observer: $\text{mass} = m_0 / (1 - v^2/c^2)$ where v is the relative velocity between observer and the mass, and m_0 is the mass when it is at relative rest. The WSM shows the origin of these two in Chapters 5 and 12.

Einstein's special theory of relativity was a refinement of the **FitzGerald-Lorentz** work showing the contraction in the length of an object at relativistic speeds, and the Lorentz transformations (1904). Lorentz described the increase of mass, the shortening of length, and the time dilation of a body moving at speeds close to the speed of light. Einstein's derivations assumed that the speed of light was a constant based upon experiments by **Michelson and Morely**, an assumption he later retracted after his 1915 General Theory of Relativity (GTR). He then realized that light speed depended on the density of the space wave-medium and was not constant, as might logically be expected. He wrote:

Special relativity is founded on the basis of the law of the constancy of the velocity of light. But the general theory of relativity cannot retain this law. On the contrary, we arrived at the result that according to this latter theory the velocity of light must always depend on the co-ordinates when a gravitational field is present.

Albert Einstein studied the mechanism of the transmission of force from one particle to another and concluded that particles must possess a property that extends throughout space to connect particles. His knowledge of Nature told him that discrete particles couldn't exist because their borders would be an abrupt discontinuity; instead particles and space must be continuous.



THE GENERAL THEORY OF RELATIVITY (1915)

Both Einstein's General Theory of Relativity (GTR) and the Wave Structure of Matter (WSM) are based upon the properties of *space*. Both are correct - both represent the physical reality of the universe. However General Relativity primarily examines the large scale, cosmic properties of space and matter in it, whereas the WSM begins with the quantum micro-scale properties of matter itself. Although his medium and the medium of WSM are identical, he did not concern himself with quantum waves or the microstructure of matter. They use different mathematical methods but they produce the same results.

CALCULATING THE GTR. Einstein's general theory is based upon the existence of a space medium that contains the matter of the universe; both matter and energy are embedded in astronomical space. Then his 4D math calculates how energy and matter determine space density everywhere in the Universe, and also how density changes evolving with time. Finally his theory calculates space-density properties on an astronomical scale to find the paths of light rays. These light-paths define the 4D coordinates of space just as grid-lines on graph paper define 2D coordinates. If matter and energy are evenly distributed, all the coordinate lines are parallel. But if not parallel the space is said to be *curved*. This complex mathematical procedure is not encountered in our 3D human world; it has caused the study of GTR to be misunderstood and used only by mathematical scientists. There is a lonely world punctuated by occasional trips to the media carrying interpretations of their work for the layman and to a government office that will fund their work. The use of waves for each mass 'particle' as in the WSM greatly simplifies this calculation.

In our real Universe, matter and energy are distributed *almost* perfectly evenly and the curvature of real space is very tiny; near zero. In order to find experimental proof of his theory, Einstein had to search exhaustively to find where the small curvature was big enough to measure. He found that close to the Sun light rays would be deflected enough by the small curvature.

In 1919 **Arthur Eddington** led an eclipse expedition to Principe Island in West Africa to verify the bending of light passing close to the sun. Such observations of stars close to the sun in the sky could only be made during a total eclipse. The eclipse was due to occur on 29 May but that morning there was heavy rain. Eddington wrote: *"The rain stopped about noon and we began to get a glimpse of the Sun...I did not see the eclipse, being too busy changing plates, except for one glance to make sure that it had begun. We took sixteen photographs. They are all good of the sun ... but the cloud has interfered with the star images. The last few images I hope will give us what we need."*

He remained on Principe Island to develop the plates. On 3 June he recorded in his notebook: One plate I measured gave a result agreeing with Einstein.

Einstein believed that a space-medium for waves must exist. In a 1928, Leiden Lecture, he said: *"According to the general theory of relativity, space*



without ether is unthinkable; for in such space, there not only would be no propagation of light, but also no possibility of existence for standards of space and time. But this ether may not be thought of as endowed with the quality characteristic of matter, as consisting of, 'particles' which may be tracked through time."

Note that he requires space to be not only a medium for waves, but also as a means to establish a universal standard (i.e. provide a mechanism) of length and time. This requirement is usually overlooked by the science community but is absolutely necessary as the basis of experimental work. The time period and wavelength of matter waves in space display these universal standards.

Oddly, Einstein did not attempt to find out how matter was shaped or formed except to say it had to be 'extended' (as are the spherical waves of the WSM). He wrote: *"Physical objects are not in space, but these objects are spatially extended (as fields). In this way the concept 'empty space' loses its meaning. ... The field thus becomes an irreducible element of physical description, irreducible in the same sense as the concept of matter (particles) in the theory of Newton."* Clearly, Einstein had all the knowledge needed to find the WSM in a few hours! Why did he miss it?

His summary of his GTR, shows he clearly realizes that the wave-center of a 'particle' (an electron) is the only place where energy density (space density) is very large: *The physical reality of space is represented by a field whose components are continuous functions of four independent variables - the co-ordinates of space and time. Since the theory of general relativity implies the representation of physical reality by a continuous field, the concept of particles or material points cannot play a fundamental part, nor can the concept of motion. The particle can only appear as a limited region in space in which the field strength or the energy density is particularly high.* (Albert Einstein, Relativity, 1950). Again, he almost had the WSM in his hands!

When asked to summarize the general theory of relativity in one sentence, he wrote: *"Time and space and gravitation have no separate existence from matter."* (Albert Einstein, Ideas and Opinions, 1954). He is re-stating the Greek concept that One Thing underlies all physics.

Milo Wolff at MIT found (1984) the complete mathematical structure of the electron and deduced that the predictions of Clifford, Schrödinger and Mach were embodied in only two simple principles of the properties of space (The subject of this book). Space-wave simplicity is remarkable. Using the scalar wave equation, he found that the wave properties of space and the simple scalar waves of the charged particles of the Universe (electrons, etc.) were the origin of special relativity, the de Broglie wavelength and the Compton wavelength and thus the Schrödinger Equation. The scalar equation became the basis of Principle I of the WSM. Then he used a quantitative version of Mach's Principle as Principle II to show how the density of space depends on all matter in the Universe. Remarkably, just these two principles together describe the origin of all the natural laws. That work is also published on the site <http://www.QuantumMatter.com>.

COMPARE THE WSM AND THE GTR: In the WSM the space medium on the quantum scale also has density dependent on the presence of the matter throughout the universe (See Principle II). The density of the medium affects the motion of quantum waves that produce the same 'light rays' as GTR. In reality light rays are energy transfers facilitated by the quantum waves. The simpler mathematics makes it much easier to envision the wave structures. The WSM and GTR both describe the same universal space, albeit on different scales of size.

Einstein, after developing the General Theory of Relativity, had an enormous knowledge of space, matter and Nature. His final major uncompleted goals were to find connections between quantum theory and the role of space and matter in Nature. Sadly, his ideas needed only slight additions to lead to the Wave Structure of Matter.

EVALUATING THE PIONEERS

The pioneers above arrived at their valid conclusions by painstaking analysis and careful adherence to the rules of logic, and the philosophy of truth. But their thinking was ignored for sixty years. 'Truth is no match for belief.' The consequences of predictions of these pioneers lead to the conclusion that matter is a wave structure embedded in the space medium. This result not only satisfies the experimental work, but also surprisingly displays an immense but simple tapestry of the physical universe. Awe-inspiring connections between matter, the cosmos, and ourselves are found. The application of the electron wave structure reaches out to unsuspected fields of cosmology such as the Big-Bang, the red shift, and the structure of the universe, as well as more practical applications in microcircuits and human physiology.

These serious thinkers, Clifford, Einstein, Dirac, Schrödinger, and Ernst Mach, realized that experimental measurements showed that the structure of matter was closely related to the properties of the apparently empty space around us, and that the elements of matter had to:

- a) Have a spherical symmetry.
- b) Be extended in space.
- c) Possess a means of exchanging energy. (Wave interactions do this).
- d) Possess wave properties (founded on wave equations).

Their thinking produced conclusions that in hindsight were prophetic:

We live in an inter-connected universe. The above discussions of the requirements of the laws of science make it clear that inter-connections must exist between matter, the laws, and the universe. Independence of objects is not possible, for example, no planet, no star, no galaxy, can exist without the rest of matter of the Universe. These requirements are not the fantasy of a supreme lawmaker who declares that his law applies everywhere. The only logical conclusion is that matter and laws are inter-connected throughout the universe by a physical mechanism - waves. As **Lee Smolin** writes ('Life of the Cosmos' Phoenix books, 1998): *"It can no longer be maintained that*



SECTION III

the properties of any one thing in the Universe are independent of the existence or non-existence of everything else."

The inter-connections originate from the sharing of the quantum waves of the particles (electron, proton, etc) with the waves of universal space. It is clear that the classic point-particle model of charge and mass substance cannot satisfy the logic of science and it causes many puzzles of physics. The present-day 'Standard Model' of physics is only a historical relic - an obstacle to progress. **Paul Davies** highlighted this shortcoming of modern physics ('Superforce', Unwin paperbacks, 1985): "*The idea that something can be both a wave and a particle defies the imagination. - The notion of a particle being everywhere at once is impossible to imagine.*"

SECTION IV MAXWELL'S ELECTROMAGNETISM: FRANKLIN, LORENTZ, MAXWELL

Electromagnetism was founded on experiments by **Alessandro Volta** (1745-1827), **André Marie Ampere**, (1775-1836), **Michael Faraday** (1791-1867), and **Carl Friedrich Gauss** (1777-1855). **James Clerk Maxwell** (1831-1879) formalized their work into a set of four famous equations that have ever since proven very useful for large-scale electrical engineering. Their subsequent fame was a result of experiments by **Heinrich Hertz** (1857-1894) that appeared to show that the electromagnetic (radio) equations of Maxwell were the basis of electromagnetic waves traveling at speed c , a wrong conclusion. The fact that many predictions of the equations conflict with experiment has been ignored in view of their extensive and valuable use in designing electrical machinery and practical apparatus.

It is not widely appreciated that the appearance of transfer of electrical energy is the observation of many coherent quantum-wave exchanges at speed c , and is not due to an electromagnetic wave that does not exist. This confusion led to innumerable useless proposals for models of 'particles' and a 'photon' that also does not exist. Einstein who created the photon concept later decided he did not know what it was or if it existed. He also rejected the point particle and Maxwell's field Equations, writing: "*The combination of the idea of a continuous field with that of material points discontinuous in space appears inconsistent. Hence the material particle has no place as a fundamental concept in a field theory. Thus even apart from the fact that gravitation is not included, Maxwell's electrodynamics cannot be considered a complete theory.*" (See Einstein).

DISCOVERY OF THE ELECTRON. When **J. J. Thompson** discovered the electron in 1904 using cathode ray tubes that enabled him to calculate the charge to mass ratio, everyone was convinced that electrons were discrete material particles. This discrete particle belief began to be questioned about 1930, because the 'wave functions' of the Schrödinger Equation do not predict material electrons unless you assume that electrons are discrete. The Equation does not demand this. It allows one to assume that discrete material electrons exist or do not exist - a free choice. The wave functions provide exacting values of energy transfers but no knowledge of how transfer happens because



the waves themselves are the transfer mechanism. Thus further progress required the abandonment of the notion of a discrete particle and accepting electron wave structure. Unfortunately, Neils Bohr, his Copenhagen group, and most physicists accepted the discrete particle and delayed the WSM for about 50 years.

THE MYSTERY OF CHARGE. Benjamin Franklin (1706-1790) visualized charge as particles that flowed on metal surfaces and could be kept in Leyden jars like a genie of the Arabian Nights. To evaluate these concepts scientists needed numerical constants, and created names "charge" and "mass" for them. The static point particle was illogically conscripted to fill a theoretical need for a vehicle to carry charge and mass from place to place. The explanation of the electron by Charles Augustin Coulomb (1736-1806), endowed it with a $1/r^2$ force but no one measured force at very small radii until QM raised questions about this popular idea of the electron - finding that it is not supported by the scientific evidence. The Coulomb force formula fails at small radii about the size of a nucleon where force levels off. No experiment has ever detected a particulate mass or charge core at the center of an electron. Further, there are no laws in which charge e appears alone. Instead, the laws always involve *two* particles so the constant involved is e^2 not e , forfeiting its affiliation with one particle. This evidence suggests that an electron wave-structure exists at small radii, and that charge is a property of space surrounding the electrons, described by a constant e^2 . This agrees with the WSM.

STRUCTURE OF THE ELECTRON. The search for the structure of the electron started over a century ago, in H.A. Lorentz's book *Theory of the Electron* (1900). But no satisfactory structure had been found until Wolff (1990) used the WSM. Before the existence of electrons, Lorentz proposed that light waves were due to oscillations of an electric charge in the atom. But he also regarded space ('ether' in his time) as possessing substance, as in the modern WSM:

"I cannot but regard the ether, which can be the seat of an electromagnetic field with its energy and its vibrations, as endowed with a certain degree of substantiality, however different it may be from all ordinary matter."

Lorentz developed his mathematical theory of the electron for which he received the Nobel Prize in 1902. Lorentz is famed for his work on the *FitzGerald-Lorentz contraction* of the length of an object at relativistic speeds. Lorentz transformations, which he introduced in 1904, form the basis of Einstein's special theory of relativity. They describe the increase of mass, the shortening of length, and the time dilation of a body moving at speeds close to the velocity of light.

In extending the work of those scientists to the mathematical structure of the electron, the WSM, in this book shows their visions have come true; the electron is a wave structure without material substances. Looking ahead, the space-medium of the waves is still largely unexplored; it is the final frontier of the future.



SECTION V
THE QM
PROBABILITY
PUZZLES OF
NEILS BOHR:
WHEELER &
FEYNMAN

The puzzles of QM arise from the mathematical choice that matter consists of discrete 'particles' with discrete point-like locations, rather than choosing that matter is a wave structure. Confusion arose because choosing either waves or 'particles' is mathematically acceptable for the Schrödinger wave equation.

The discrete 'particle' choice is termed the **Copenhagen interpretation** formulated by Niels Bohr and Werner Heisenberg while collaborating in Copenhagen around 1927. The difficulties of the interpretation arise because the wave functions cannot provide a discrete location for a discrete 'particle'. Bohr and Heisenberg adopted a probabilistic location for the 'particle' within the wave function as proposed by Max Born.

Many physicists and philosophers objected to the Copenhagen interpretation on the grounds that it gives a non-deterministic location for a 'particle' assumed itself to be a determined object. Einstein's famed quotations "*God does not play dice.*" and "*Do you really think the Moon isn't there if you aren't looking at it?*" exemplify this. Bohr, in response, said "*Einstein, don't tell God what to do.*"

Quantum mechanics was initially developed to explain why the electron stayed in orbital motion that couldn't be explained by Newton's laws of motion. The search was motivated by the assumption that a discrete electron has a discrete orbit; but neither of which are needed if the electron is a wave structure.

According to Born and Copenhagen, electrons cannot be pictured as localized particles in space but rather should be thought of as "probability clouds" of negative charge spread out over the entire orbit. This probability cloud obeys a principle called **Heisenberg's Uncertainty Principle**, which states that there is an uncertainty in the classical position of an electron. Therefore, the improvised Copenhagen quantum mechanics contrasts with Newton's deterministic description of nature.

Wave functions can change as time progresses. The Schrödinger equation describes how wave functions change in time, a role similar to Newton's second law in classical mechanics. The Schrödinger equation, applied to a free particle, predicts that the center of a wave packet will move through space at a constant velocity, like a classical particle with no forces acting on it. However, the wave packet will also spread out as time progresses, which means that if you assume particles exist the position becomes more uncertain.

Some wave functions produce probability distributions that are constant in time. For example, a single electron in an unexcited atom is pictured classically as a particle moving in a circular trajectory around the nucleus, whereas in quantum mechanics it is described by a static, spherically symmetric wave function surrounding the nucleus. The time evolution of wave functions is deterministic in the sense that, given a wave function at an initial time, it makes a definite prediction of what the wave function will be at any later time. However, during a measurement, the change of the wave function into another one is not deterministic, but rather unpredictable, i.e., uncertain.

The probabilistic nature of quantum mechanics was the central topic in the famous Bohr-Einstein debates, in which the two scientists attempted to clarify these fundamental principles by way of thought experiments.

AN EARLY VIEW OF WAVE STRUCTURES. In 1945 Wheeler and Feynman (W&F) sought the cause of the radiation from an accelerated charge. Their calculation assumed that the charge generated equal amplitudes of advanced (inward) and retarded (outward) spherical electromagnetic waves. The outward waves evoked a *response of the universe*; that is, the production of inward waves from absorbing charges elsewhere in the universe. The absorber waves began *before* arrival of the source waves. The calculated forces due to combined local and absorber waves agreed with an empirical formula by Dirac and appeared to be the cause of energy transfer. Their remarkable result attracted much attention. However, contrary to their assumption, there are no mathematical electromagnetic wave solutions in spherical coordinates! In hindsight, the success of the W&F calculation was due to suppression of the vector electromagnetic waves so that in effect they were calculating *scalar* (quantum) waves as in the WSM.

THE CALCULATION BY WHEELER AND FEYNMAN. W&F wished to verify the empirical formula for the force of radiation used by Dirac:

$$\text{Force} = [da/dt]^2 e/3c^2$$

Where e is the electron charge, c is the velocity of light and a is the acceleration. The mechanism of the force was unknown. They discussed this problem with Einstein who suggested a proposal by **Tetrode** [1922] that light (energy) transmission was not a one-way process, but two-way communication between a source molecule or atom and a receiver molecule utilizing inward and outward waves. This proposal was not popular since it appeared to violate the causality concept: *Actions should appear before their causes*, because the inward waves appear to be traveling backward in time. Electromagnetic waves were assumed generated by the acceleration, using special solutions of the electric-vector wave equation,

$$\text{Kinetic energy} + \text{potential energy} = \nabla^2 E - [1/c^2] \partial^2 E / \partial t^2 = 0$$

Outward traveling spherical waves encountered absorber charges in the universe that produced spherical inward waves that returned to the initial charge, a response of the *Universe*. The inward waves from the universe were assumed to begin before the acceleration occurs.

Remarkably, no inward waves appeared to violate causality because the inward waves from the absorber were cancelled upon arrival by interference with waves from the source charge. The remaining wave fields gave the disturbance demanded by experience in agreement with the prescription of Dirac.

W&F summarized the behavior of their inward waves: *Absorber charges at a large distance produce spherical waves headed towards the source. At the moment the source is accelerated, these waves just touch the source. Thus all the waves from the absorber charges form an array of approximately plane waves*



Marching towards the source. The (Huygens) envelope of these plane waves is a spherical in-going (advanced) wave. The sphere collapses on the source, and then pours out again as a divergent outward wave.

PHILOSOPHICAL IMPORTANCE. W&F's work had implications beyond an explanation of radiation force because transfer of energy and the motion of matter are among the most fundamental processes of science. Further, the concept that spherical waves from all matter of the universe perform a role of charged particles suggests that the whole universe is involved, i.e. every charged particle is a structural part of the universe and the whole universe contributes to each charged particle. Their work pioneered the concept that every particle sends quantum waves outward, and receives an inward response from the universe. In hindsight, if they had used scalar quantum waves entirely, the WSM might have appeared 55 years ago.

John Cramer reviewed the paradoxes of quantum mechanics in the *Reviews of Modern Physics* (1986) and proposed that the Wheeler-Feynman waves were actually the behavior of real quantum waves. In his *Transactional Interpretation of Quantum Theory*, an emitter particle ready to radiate sends out an "offer wave". Potential absorber particles reply, sending back a "confirmation wave". Then another set of waves provides a "handshaking" action to establish an energy transfer. This is the essence of the energy transfer mechanism of the Wave Structure of Matter. He shows, in the academic jargon of quantum theorists, that inward and outward waves are a valid interpretation of quantum theory as in the WSM. His important step was to declare quantum waves as real.

SECTION VI
RECENT
FORMULATION
OF THE WAVE
STRUCTURE
OF MATTER:
MILO WOLFF,
CARVER MEADE,
AKI TONOMURA,
GEOFF
HASELHURST
& OTHERS

Following the advances of W&F, Schrödinger and Einstein, little research was done on the structure of particles until 1985. After 1945, particle physicists chose to work on post WWII weapons; research on wave structure stopped.

Milo Wolff in 1985 began the first mathematical theory of the WSM using a scalar wave equation with spherical quantum wave solutions. He found the Wave Structure of Matter described in his earlier book (1990) *Exploring the Physics of the Unknown Universe – An Adventurer's Guide* and this book. It successfully predicted the natural laws and the properties of the electron. This book continues that work on the natural laws including a derivation of gravity and the physical origin of spin that accords with experiment, quantum theory and the Dirac Equation (See Chapter on Spin). It completes the structure of the electron and its waves and extends applications to cosmology.

NEW PIONEERS. Many younger physicists have begun to explore the WSM further; most of their work is published on the Internet, including **Geoff Haselhurst** in Australia who has extensively explored (1998 to present) the philosophical background of the WSM shown on his entertaining and deeply researched website: SpaceAndMotion.com. He contributed the origin of



From these definitions you can deduce the simple rule that wavelength times frequency equals velocity. That is:

$$\lambda \times f = c$$

Different kinds of waves travel at different velocities. Sound waves travel in air at 1100 feet per second, and quantum waves travel in space at $c = 300,000,000$ meters/second.

WAVES ARE PRODUCED BY ENERGY EXCHANGES. If you are curious, you might ask, why do waves occur? And, if they are universal, what universal situation leads to their production? Waves do not exist without a media that determines their form and type. For example, a stringed musical instrument wave needs a stretched string as its media. Sound in air or waves in musical pipes need air under pressure as media. Waves on the surface of a lake travel in water that is pulled downward by gravity. The answers to these questions require us to study the media (space) in which the waves travel. First of all, the media is a storehouse of energy; the space around us, and in the entire Universe, has an enormous but un-noticed energy content. The media must always have two properties: 1) Motion of the media produces kinetic energy, and 2) Displacement of the media involves a force that produces potential energy. Many types of media exist and many kinds of waves exist, but all have these two properties that can be written:

$$\text{Kinetic energy} + \text{Potential energy} = \text{a constant}$$

As the wave proceeds in its travel, there is a continual exchange between potential and kinetic energy in time with the frequency of the wave. Examples of the energy exchange are easy to find. Consider a very illustrative case: an underwater elastic membrane enclosing an air-bubble connected to a pulsating air pump. This is an underwater sound source. The pump alternately increases and decreases the air in the bubble. When the bubble is changing its size, the water surrounding it is in motion and thus has kinetic energy. When the bubble enlarges the compressed air inside has potential energy. The oscillating bubble continually exchanges its energy between these two forms. Outside it will generate a water wave that travels radially out through the water.

The wave traveling along a string has kinetic energy (KE) due to the moving mass of the string and potential energy (PE) because of the stretch of the string. An electromagnetic wave is said to exchange its energy between electric and magnetic fields although this example is hard to visualize. In reality it is many quantum waves traveling in an elastic space.

When a wave begins at its source, energy is abstracted from the source due to the oscillating behavior of the source. And when the wave reaches another oscillator, this energy can be delivered to the oscillator, but only if there exists a mechanism to enable the waves to transfer energy to it. An exchange



mechanism is essential and both source and receiver must be resonant with each other. The mechanism is non-linearity, described below.

SPACE IS THE COMMON DENOMINATOR OF WAVES. It is curious that despite the great variety of wave types, such as mechanical waves in metal, light waves in space, sound waves in air, water waves, etc.; if you analyze them to find what is happening on a microscopic level you discover they all appear to be related to the properties of space. For example, the media of sound waves is matter composed of atoms. The KE of the sound waves is actually KE of the relative motion of the atoms, and the PE is from the forces between them. Ultimately all types of waves are our observation of large numbers of quantum wave exchanges. This is because there is just one real wave media of Nature; this is *space*.

At the basic quantum level in *space* we need to think more carefully about waves: Measuring wave displacement to determine potential energy (PE) demands that we understand the meaning of length. We previously concluded that length is a property of space. Similarly, if we want to determine motion or velocity to find kinetic energy (KE), we must understand the rate of change of length with time, and we had concluded in Chapters 2 and 3 that time also has a special relation with space that puzzled us at first. It is now comforting to realize that waves, length, time, and energy, as we had anticipated, are all properties of *space*, the one thing of the Universe.

A TYPICAL WAVE IS SINUSOIDAL. It is commonly observed that waves of pure tone or constant frequency have the form of a mathematical sine or cosine. How does this occur? It is because the forces in the oscillating media are balanced at all times. If forces are balanced, the following must be true:

Rate of change of KE/velocity = rate of change of PE/ displacement.

When you write this rule using the calculus you get a wave equation whose solution is always a sine or cosine function, such as

$$\text{Amplitude} = A \sin 2\pi(ft - x/L)$$

The A in the equation represents the maximum amplitude of the wave. The frequency f of oscillation varies according to time t , and L is the wavelength. The $-$ sign in the parentheses means the wave is traveling along the x axis in the positive direction. If a $+$ sign is used, the wave travels in the opposite direction. We observe that the sinusoidal property is equivalent to the property of exchanging KE and PE energy back and forth.

VECTOR WAVES IN 3D SPACE CAN BE POLARIZED. If the wave amplitude also has a direction, then the 3D character of our world has entered the picture. We describe this by *polarization*. For example, the wave of an electric field represents the amplitude and direction in which a charge would be forced. If the electric field points in one of the 3D directions, either x , y , or z , that direction names the polarization. If a wave is moving in, say the z

direction, and the field is pointing in the y direction, one says the wave is y -polarized.

In Nature, nearly all electric waves are polarized in directions perpendicular to the direction of travel. If the wave travels in the z direction, the wave could be either x -polarized or y -polarized. Ordinary light waves from the Sun, or fire, or candles are not polarized. Instead they are random mixtures of both polarizations which on the average have no net polarization. Light reflected from a smooth surface is always polarized because the surface suppresses the perpendicular component. Polarized eyeglasses can reduce the glare from such surfaces.

An arrangement of two polarized waves traveling in the same direction can result in a total wave vector which twists like a helix, called circular polarization. The wave vector rotates CCW like a left-hand (LH) screw if the two waves are perpendicular to each other and the phase of one of them lags behind the other by -90° . Similarly, if the phase difference is $+90^\circ$, the rotation is CW like a RH screw. This property is often used in satellite microwave radio to avoid interference of signals since a receiver that receives LH circular waves cannot receive RH circular waves.

SCALAR WAVES HAVE NO VECTOR AMPLITUDE. The amplitude of the wave is just a number called a scalar. For example, sound is a scalar wave of varying air pressure. Along the path, the pressure rises and falls above the ambient pressure of the normal air, and the amplitude is the varying value of the pressure, as a sine wave. Quantum waves are scalar; the only type possible in the space media.

QUESTION FOR THOUGHT:

WHAT ABOUT A WAVE ON A STRING? IS IT A VECTOR OR A SCALAR WAVE?
IS IT POLARIZED?

Among the most important concepts to grasp are resonance and standing waves. These are fundamental to almost every branch of physics. They underlie the production and perception of speech and music and have countless applications in engineering. Resonance is what allows gentle pushes on a child's swing to raise it ever higher. It is what has caused the collapse of seemingly strong bridges by unceasing winds and marching armies. Broadly speaking resonance is the creation of an oscillation by an incoming wave that delivers energy with the same frequency as that of a naturally vibrating object. If the two frequencies are the same, waves are always in phase and energy continues to build up. If they are of different frequencies, the energy exchange is out of phase and there is no build-up. A standing wave is closely tied up with resonance and it is not possible to fully understand one without grasping the other. Standing waves occur whenever a steady wave hits a reflecting barrier. The reflected wave has the same speed

SECTION I



SECTION II REFLECTIONS, RESONANCE & STANDING WAVES



and frequency as the impinging wave so that the wave peaks and troughs interfere with each other making a pattern of 'nodes' and 'anti-nodes'.

WAVES REFLECT WHEN THE MEDIA CHANGES. When a traveling wave encounters a change of the properties of the medium in which it travels, all or part of the wave is reflected. Partial reflection divides the wave into two waves, traveling in opposite direction. Frequently, like the image behind a mirror, one of the waves is not really there. But sometimes there may actually be two waves.

Look at the simple example of a one-dimensional wave on a string. Suppose that one end of the string is held by fastening it to a solid wall. This results in the condition that the displacement of the string must be zero at the wall. If the wave is traveling towards the wall, then a mathematical way of keeping the amplitude at zero is to assume the existence of a second wave traveling away from the wall whose amplitude is equal and opposite to the first wave at the position of the wall. It would make no difference if we just clamped the string at that one point to represent the wall. The two oppositely traveling waves must be sinusoidal and must have the same wavelength in order to satisfy the condition of zero amplitude at the wall.

A STANDING WAVE IS A COMBINATION OF TWO WAVES. Consider a different situation. What happens if the string, of length L_0 , is clamped at both ends? Then the amplitude of the combined waves must be zero at both ends. This is only true if $\sin(2\pi L_0/L) = 0$ that is $L_0 = nL/2$ where n is an integer. That is the string length is exactly half the wavelength. Musically, this says that if $n=1$ the string will vibrate at the natural frequency of the string, and if $n=2$ the frequency is double; an octave higher. If $n=3$, it is yet another octave higher, etc. Thus the string can vibrate at many possible frequencies, provided the string length is an integer multiple of the wavelength. Also more than one of these frequencies can occur on the same string; the waves are superimposed.

Sometimes there are two oppositely traveling waves on the string. Their amplitudes will combine, and if the wavelengths are the same, the appearance of the string is a to-and-fro vibration, with no apparent traveling motion. This is called a *standing wave*; that always occurs in musical stringed instruments. Important for this book, the electron is a standing wave of the combined in- and out- spherical waves.

Waves can also travel simultaneously in several dimensions; for example across the surface of a drumhead. Standing waves also occur across the drumhead. A condition imposed upon the waves is that amplitude must be zero all along the edges of the drum. This leads to mathematical complexity for the shape of the wave patterns because a drum edge is complicated math but you need not worry because the general idea is the same as the string, where the wave sets are in simple straight lines.

Three dimensional (3D) standing waves can occur in boxes of various shapes, for example, within the body of a violin. Because of the complicated shape of the violin, an analysis by mathematics would be too complicated to be useful even if it could be solved, but you can be sure that the best violin makers know where the

standing waves occur and what their relative amplitudes are. They have learned by experience using their eyes, ears, sense of touch, and brain, but no math!

REFLECTIONS IN AN OPEN PIPE. Clamping a string or drumhead is not the only way that the properties of the media can be changed. When a wave travels down a pipe such as a trombone, a reflection occurs at the end of the pipe. This is because the properties of the media (air) inside depend partially on the shape of the pipe. Where the pipe abruptly ends, a condition is imposed on the two traveling waves: Total wave amplitude = a maximum. If the pipe is open at both ends, a wave maximum occurs at both ends. If one end is closed, the amplitude = 0 at that end, and a maximum at the open end. Partial reflections will occur and standing waves will appear.

WHAT ARE THE RULES FOR ADDING TWO WAVES? What happens to amplitude when two waves travel together? To learn this we need rules from Nature for adding together the amplitudes of the waves. These rules are simple - you always add amplitudes where two positive crests or two negative crests occur together, and you subtract them if trough and crest occur together. In between, add the waves following the rules of algebra with sine and cosine expressions. The technical term for the phenomenon of waves joining each other is *interference*; *positive interference* if reinforcing or *negative* if canceling.

INTERFERENCE OF DISSIMILAR WAVE FREQUENCIES PRODUCES BEATS. When two waves travel together there may be interference in time. An example is two sources of sound which have slightly different frequencies which we listen to at the same time. When the two waves arrive with their crests together so that the amplitudes add; we hear a sound peak. When a crest of one and a trough of the other are together, the amplitudes cancel and we hear nothing. The rising and falling of sound is called beats. It is interference in time.

REPEATED REFLECTIONS CREATE A STANDING WAVE. Interference in space occurs when two waves of the same frequency are confined in the same space such as in a trombone pipe or on a violin string. The wave is confined because there are reflections at both ends of the string or pipe. One wave is traveling towards an end, and its reflection becomes a wave traveling in the other direction. If the crests of the two waves always occur together at the same place, and if both waves have identical frequencies, and if the reflections occur continually, then the two waves appear motionless and a standing wave is seen. This is the normal situation in a musical instrument.

The standing wave of an electron occurs with one end at the spherical wave center and the other end effectively at infinity. All electrons have the same frequency and properties because the medium (space) is nearly the same everywhere throughout the Universe.

RESONANCE IS A LOVE-AFFAIR BETWEEN TWO INSTRUMENTS. If two standing waves, say one on a violin and the other on the piano, have the same frequency, then sound energy can be transferred between the instruments. You can try it. Place the violin near the piano and strike a piano key



corresponding to one of the tuned strings. Stop the piano note and you will hear that the violin has picked it up! To describe this, we say that the strings of the two instruments are in resonance with each other. This resonance allows energy exchange. You can also try this just using the piano by striking a bass register note, say D, and at the same time holding the damper off a higher D note. The higher D will resonate with the lower note and absorb some energy. You can hear it by taking your finger off the bass D note while holding the higher D. The high note will remain.

A resonance condition can occur in other situations, too. People who say, "My ears were ringing!" were probably in resonance with a component of a loud sound. Lovers may claim that their thoughts and feelings resonant with each other! The yellow light emitted from heated sodium atoms will be absorbed resonantly by a different layer of sodium vapor placed in the path of the light. A tuned device is often termed a "resonance or resonator" of a particular frequency if its dimensions match that frequency. It is important to remember that resonant energy exchange is produced by many back-and-forth waves traveling between the source and receiver. It is not a single wave event.

INTENSITY OF A WAVE IS PROPORTIONAL TO THE SQUARE OF THE AMPLITUDE. Light waves, as well as other types, are able to exchange energy and momentum from one oscillating atom to another. When this occurs in a light beam, measurements show that the intensity or power of the beam is proportional to the square of the amplitude of the electric field. That is

$$\text{Power} = E \times E \text{ watts per square meter}$$

The same intensity relation is true for other waves too, such as sound. But don't forget that an electromagnetic wave is really the total effect of many tiny separate quantum exchanges.

ELECTROMAGNETIC WAVES ARE SPECIAL. The waves of light, radio, x-rays and other members of the electromagnetic spectrum stand apart from sound, and other mechanical waves. They are unique as well as different. Their speed of propagation c is a fundamental constant of Nature, because c depends on the properties of the space media. This is different than the speeds of mechanical waves that vary widely and depend on different mechanical properties of the media in which they travel. Only quantum waves are described by the fundamental equation:

$$\text{energy} = E = mc^2 = hf.$$

Nature appears to have chosen these waves as the messengers which bear the laws of Nature. The energy mc^2 implies the law of relativity, and the energy hf implies the laws of quantum theory. Both arise from the WSM. Laws and calculations of the waves yield precise matches with measurements. Still, there is widespread confusion; especially, the mistaken notion of a photon as a discrete energy vehicle is fraught with contradictions.

Unique and fundamental are the "matter waves" of electrons and quantum theory. They are scalar waves and we can calculate their behavior precisely from the WSM. Their frequency is proportional to the energy of a particle and their wavelength is inversely proportional to the momentum of the 'particle'.

We feel that we thoroughly understand a sound wave because it is in a familiar media; the air in which it travels from a source to the listener. Sound is a study of the motion of gases and can be completely understood in terms of Newton's laws, we imagine. The propagation from one place to another is merely a consequence of mechanics and the properties of the air media. If it propagates through a liquid or a solid, it depends on their mechanical properties. Familiarity gives us confidence and mitigates our skepticism. But in fact, upon close examination sound waves are found to be composed of atoms undergoing quantum waves. So our confidence in pure sound waves is an illusion!

In order for a wave to be sensed or detected by our ears, eyes or instruments, the detecting device must have a non-linear property that allows an energy exchange.

YOU NEVER KNOW A WAVE UNTIL YOU SEE IT, HEAR IT, OR FIND IT!

In the discussions above, an extremely important but subtle assumption has been made. We assume that amplitudes are able to reinforce each other simply because we ourselves are able to hear sound waves or see light fringes. In fact we haven't thought about how Nature combines wave amplitudes or how we sense them. Reflect a while about this. People see or hear the interaction of waves using the automatic sensors built into our heads. From childhood we learn about light and musical sounds by experiencing them with our own senses, so we assume this process always exists as an instinct. However, in order to sense a wave an energy exchange has to occur and this only happens if the media is non-linear. We cannot be misled by human sensory experience to assume that energy exchange will always occur. Instead, we must understand the process of interaction between waves, and the means of detecting them. We need to study the mutual detection process involving energy exchange that occurs when atoms and particles interact with each other. By the way, musical geniuses have acutely developed non-linear sensors in their ears, brain, and memory, far beyond those of us who are 'normal'.

SENSING WAVES. The act of detection is the act of being an observer, a concept that is central to relativity and quantum theory; things we would like to understand better. This strikes at the heart of the problem of understanding space. We will learn that space possesses the properties responsible for the interaction and combination of different waves. The key property is non-linear media.

For electromagnetic waves in electronic apparatus the detection process depends on a *non-linearity* of the media in which the waves travel. We are not conscious of it but our ears and eyes also have non-linearity built into them. Waves travel undisturbed when the media is linear. Expressed in math

SECTION III NON-LINEAR MEDIA & ENERGY EXCHANGE



a device is linear when an output amplitude is proportional to an input amplitude:

$$\text{If linear: } A(\text{out}) = A(\text{in})$$

The linear device might be a material where acceleration is proportional to the force applied, or an electronic circuit element in which the current flow is proportional to a voltage applied.

When the wave media is linear, the waves do not interact. For example, if you throw two stones into a lake, each will create a circle of expanding waves that intersect each other but don't interact. As you watch, each set of circles grows larger without interference by the other. The surface of the lake is a linear wave media.

A long string of uniform size and tension is a linear media. Waves traveling along it can meet waves traveling in the other direction and both will pass through each other without disturbance. Billions of electromagnetic signals travel through space, constantly intersecting each other, yet never interfering or mixing with each other. Space is clearly a linear media for most waves.

A NON-LINEAR MEDIA TRANSFERS INFORMATION BETWEEN WAVES.

We are more interested in non-linear devices where output is not proportional to the input. That is, a graph of input vs. output will not be a straight line through the origin. Non-linear devices are important to energy exchange. Consider what happens if we apply a pure sine wave to the input of a non-linear device. First, the output will not be a sine wave; instead it will be distorted, and harmonics of the sine wave are produced. Second, if the input should be two or more waves, the output will not only contain harmonics of the two pure inputs, but each wave will contain components of the other. That is:

If the INPUT = $A_1 \cos(f_1 t) + A_2 \cos(f_2 t)$, then:

$$\text{OUTPUT} = (k/2) A_1 A_2 [\cos(f_1 + f_2) + \cos(f_1 - f_2)] + \text{INPUT} + \text{harmonics}$$

The math is not so important as the idea that the two signal frequencies are mixed by a non-linear device; that is, the non-linear device has created *modulation* of one signal by the other. Each signal wherever it goes carries information about the other signal. Notice that this effect is proportional not only to the degree of non-linearity k , but also to the product of the two amplitudes.

There are many real situations where non-linear devices occur. Our ears are non-linear which accounts for the fact that we can hear sum and difference frequencies (beats) when two musical instruments are played near each other. Some persons with 'perfect pitch skills' are able to hear harmonics. Radio transmitters incorporate a non-linear device, called a modulator, to impress the audio signal to be transmitted onto the radio carrier wave. The radio receiver also includes a non-linear device termed a de-modulator, which extracts the desired audio signal from the carrier. On the other hand, hi-fi

sound equipment is carefully designed to be as linear as possible to avoid distortion. Laser light sources are so intense that they cause the wave-transmission properties of glass to become non-linear so that when red light passes through, its second harmonic comes out as ultraviolet light.

The detection of an e-m wave traveling in space is also a non-linear event. When an e-m wave encounters a charge, say an electron, we observe that the wave affects the electron, or vice versa, and can transfer energy to it.

QUESTION:

HOW DOES THIS HAPPEN? DOES THE ELECTRON CREATE
A BIT OF NON-LINEAR SPACE?



THE MAGIC OF COMPLEX NUMBERS CAN BE APPLIED TO SINUSOIDAL

WAVES. In algebra an exponential function can be made equal to the (complex) sum of a sine and a cosine function. This fact is used as a neat mathematical trick to make the algebra of waves easier because exponentials are easy to manipulate. All you do is to let the amplitude of the wave equal an exponential function: $\exp[i2\pi(ft - x/L)]$. The real part of this exponential is a sine function. Since the real and imaginary parts never mix with each other during math manipulations, you may do all the easy algebra using the exponential function. Then at the end, just take the real part of it. This yields the same result as if you used the sine function all along. Frequently you need to find the square of the amplitude of a wave. This is also easy using an exponential. All you do is multiply the complex amplitude by itself. This is often written $A^2 = A \cdot A$, where the A is the amplitude's "i" replaced by "-i".

IMPORTANT CONCLUSION. The importance of understanding waves is underscored by the fact that application of wave ideas to the unseen quantum waves of the Universe around us yields the fundamental laws of the universe that govern our science and our lives.



CHAPTER

EIGHT

ENERGY IS THE SUBSTANCE OF MATTER AND THE UNIVERSE

- I. Energy is Space – The Building Material of Matter
- II. Energy Transfer and the Basis of Knowledge
- III. Energy and the Structure of Particles and Molecules

*“Normal science...is predicated on the assumption that
the scientific community knows what the world is like
— scientists take great pains to defend that assumption.”*

– Thomas Kuhn (1962)



Energy is the most important property of our Universe. Not only does it power the day-to-day needs of our lives but also it is closely related to the space substance of which we are made. In short, not only do we use it, but also, *it is us*. We, and the science community generally do not realize how fully we are immersed in a Universe of energy – like the fish who know nothing else but water. After we study it and realize the meaning of space and energy, an immense window opens on the Universe around us, and within us.

Energy is not as simple as we imagine when paying the electric bill or buying gas for our car. Because it is basic to the Universe, and smaller things like the logic of computers, it has many facets that are not well understood. For example, our ordinary meaning of energy is actually an *energy transfer*.

ENERGY IS THE SUBSTANCE OF SPACE. Space is the medium of the quantum waves of the Universe that constitute the matter we observe. Because the substance of space is energy, one can truthfully say that energy is the mortar of the sculptor of the Universe - Nature. Or if Nature is an artist, energy is her palette and paint. Remarkably, energy as the space medium is all that is necessary to build a Universe of matter and laws. Energy, as space, is the '*one thing*' of the ancient philosophers and in modern science it is the single most important property of space because everything else derives from it, the small electron to the entire universe. It is the purpose of this chapter to make clear the meaning of energy, how it exists around us, and how we observe its appearance as the day-to-day common form of energy. Knowing that matter and the laws of Nature are the *appearance* (Schrödinger's observation) of the wave structures in space, we can easily see how study of the Wave Structure of Matter leads to understanding of Nature. Everything derives from one thing: space and its energy.

It is also easy to recognize how confusing Nature formerly was when using the notions of a multitude of discrete particles. One had to somehow imagine how matter was to be made of an infinite assortment of different bricks, sand, and rocks (and the unlimited hadrons, quarks, etc. from accelerator machines joined together with cements of gluons, photons, Higgs, etc.) If one seeks simplicity of Nature, this was clearly not the right path to follow.

UNDERSTANDING ENERGY EXCHANGE. The fact that energy is the main player in the Universe becomes evident when we notice that: We cannot measure anything in Nature without an energy exchange that tells us something has happened. Experience tells us that communication or acquisition of knowledge of any kind occurs only with an *energy transfer*. Natural law describes energy exchanges. Storage of information, whether in a computer disk or in our brain, always requires an energy transfer. Energy is required to move a needle, to magnetize a tape, to stimulate a neuron. There are no exceptions. This rule of nature is embedded in biology and our instruments.

SECTION I ENERGY IS SPACE: THE BUILDING MATERIAL OF MATTER



Thus, finding the energy transfer mechanism between particles is part and parcel of understanding the Universe and the natural laws. We must probe energy deeply and understand where it is and how it moves. We cannot accept any statement about the measurement of a natural event unless we verify the energy exchange that allowed it. Skepticism is good for science.

FEYNMAN'S THOUGHTS ON ENERGY. In 1963, energy was very mysterious. Richard Feynman in his famous Cal-Tech lectures (1963) said: *"There is a fact or law...governing all natural phenomena that are known to date. This law is called the **conservation of energy**—it is exact as far as we know... It is not a description of a mechanism or anything concrete; it is just a strange fact that we can calculate some number and when we finish watching Nature go through her bag of tricks and calculate the number again, it is the same... The energy has a large number of different forms and there is a formula for each one... It is important to realize that in physics today, we have no knowledge of what energy is. However there are formulas for calculating some numerical quantity, and when we add it all together it gives—always the same number. It is an abstract thing in that it does not tell us the mechanism or the reasons for the various formulas."*

Despite the mystery, the common denominator in Feynman's day that allowed science to find and choose the various formulas was that the energy, whatever the reason, could always be used to do work. Work energy was always equivalent to moving a force a certain distance. That became the definition:

Work energy = force x distance moved.

Today, forty years later, the Wave Structure of Matter (WSM) has removed much of the mystery because now we know the reason for and the origin of the Energy Conservation law. Nevertheless, there is still some mystery left because energy is the substance of the wave medium of the matter waves that we do not yet understand. That medium—the space around us—underlies all of physics and the sciences that grows from it. But what is the space medium? This is the final un-answered question of science!

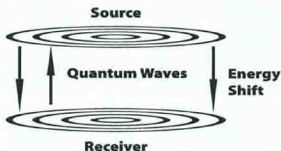
ENERGY IS BOTH COMMONPLACE AND YET INFINITELY SUBTLE. Most of us think we understand energy because it is so familiar to us every time we fill the tank of our car with gasoline or flip a switch of the microwave oven. This is deceiving. In ordinary life we see only one of the practical properties of an energy exchange but not its hidden role as the substance of matter and the laws of Nature.

At first when we learn that the space around us has the character of energy we might imagine that we have a limitless supply of energy if we could only find a way to tap it. This is an illusion of hasty thinking because the 'energy' we commonly think about is a *transfer of energy*. It is an important property of space that we observe energy transfer only when an exchange of energy from one state to another occurs as in Figure 8.1. Until this happens; that is,



two resonant states exist, we have no awareness of space, its energy content or where it is located. We are always bound by the law of conservation of energy and we find there is no free lunch. After we understand what energy is and how basic it is to science, our knowledge can lead to other values.

ENERGY IS ALSO KNOWLEDGE OR INFORMATION. In ordinary life, we see energy in two ways. One, we see it is as the tool of industry – as our servant that does all our work for us. In another way energy is also bits of knowledge or information. This simple fact is seldom noticed. Perhaps because it is 100% true, we feel there is no need to discuss or think about it! A serious mistake for a scientist.



*Energy Exchange is a quantum state shift
in a Source (down) and in a Receiver (up)*

Figure 8.1.

Between electrons, the spherical IN and OUT waves of the source and receiver oscillate back and forth until a minimum amplitude condition is obtained. The decrease of energy (frequency) of the source will equal the increase of energy of the receiver. Thus energy is conserved. We observe e-m waves as a large number of such quantum changes.

THE SIMPLE WAVE EQUATION. The equations of waves can be reduced to a simple statement that:

$$\text{Kinetic energy} + \text{potential energy} = \text{a constant}$$

(Equation 8.1)

In other words a wave equation describes the way Nature switches two kinds of energy back and forth with motion according to Equation 8.1. That is, every small part of the elastic medium is at first in motion with kinetic energy, and then it slows down as the medium stretches and changes the energy to potential energy. This goes back and forth and the motion takes the form of a sine wave. For example the wave Equation, which is Principle I of the Wave Structure of Matter, is the same as this statement but uses math to describe it. Math makes it easy to find new properties but the simplicity is lost. Likewise the waves in a violin string, or waves in water, or a light wave can all be described by the energy equation above. But matter waves are not exactly like water waves or violin strings; the fundamental waves of the Universe are quantum waves and the wave medium is the space around us.



The mathematical versions of the wave equations are so useful for analysis of waves that the math users often never knew what the math means or where it came from. Instead they feel mathematics is a property of nature that exists and accept it without question but this is not true – mathematics is only a useful tool to describe Nature. This situation is important for those readers who are curious philosophers. It is useful to understand both the simplicity of nature as well as the tools of mathematics. Together both are more powerful.

THE ORIGIN OF THE CONSERVATION OF ENERGY. A basic law of science is the conservation of energy. Notice right away that Eqn. 8.1 above is a statement of energy conservation. Before this book was written no one knew the origin of the Conservation of energy. The famous physicist Richard Feynman in his three volume series "The Principles of Physics" (1963) pointed out that the different forms of energy were discovered experimentally and a thing called energy was always conserved as it changed from one form to another. He described this, "*Nature has an honest book keeper but no one knows how she does it.*" Now you readers who study the WSM know how she does it – Energy is always exchanged by waves from one form to another. The exchanges are *resonant between source and receiver*, requiring that energy gained equals energy lost, as shown in Figure 8.1

The MAP Principle III is the disciplinarian of the universe. That is, energy transfers take place and wave-centers move in order to minimize total wave amplitude. Amplitudes are additive, so if two *opposite* resonances move together, the motion will minimize total amplitude. This explains empirical rules such as, "Like charges repel and unlike charges attract," because those rules minimize total amplitude. The origins of other rules are also now understood. For example, MAP produces the **Pauli Exclusion Principle**, which prevents two identical resonances (two fermions) from occupying the same state; Two identical states are not allowed because total amplitude would be a maximum, not a minimum. The operation of MAP is seen in ordinary situations like the water of a lake, which levels itself, and in the flow of heat that always moves from a hot source to a cold sink. These are examples of the increase of **entropy principle**.

SECTION II ENERGY TRANSFER & THE BASIS OF KNOWLEDGE

The energy transfer mechanism between atoms and molecules occurs at the high-density wave-centers, which permits coupling to change their wave frequency. When the waves of a potential source and a potential receiver pass through each other's centers, and an allowed transition exists between them, the Minimum Amplitude Principle (MAP) minimizes the total of both amplitudes by choosing the transition. In the source, the frequency (energy) of the wave state shifts downward. In the receiver, there is an equal shift upward, as in Figure 8.1. Only wave states (oscillators) with equal frequencies 'tuned' to each other can couple and shift frequency, not too different from rules of tuning up an orchestra matched to the 'A' played



by the first violin. Accordingly, the frequency (energy) changes must be equal and opposite. This is exactly the content of the **Conservation of Energy** law.

The Morphology of a Frequency Change

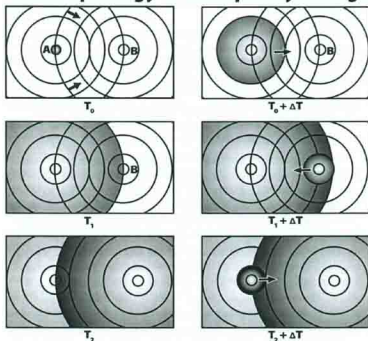


Figure 8.2.
The mechanism of an energy exchange.
The IN and OUT waves of two atoms A and B, communicate wave information about each other and behave like two coupled oscillators with waves going back and forth. If a transition exists with lower total wave amplitude, the Minimum Amplitude Principle (MAP) will cause the transition. Atom A, the source, will shift frequency downward and atom B will shift equally upward, thus complying with the conservation of energy.

This mechanism also describes the proposal noted by Einstein in the writing of Tetrode (1922) "*When I see a star 100 light-years away, the star knew that its light would enter my eye, 100 year ago — before I was born!*" Tetrode was predicting that energy exchange is a two-way symmetrical resonance exchange between source and receiver—not a one-way photon. This exchange mechanism is shown in Figure 8.2.

If you keep the traditional assumption that matter consists of points of mass and charge substance, and that energy exchange is a one-way photon bullet traveling between particles, there is no mechanism as Einstein realized below. You are doomed to the paradoxes of: causality violation, wave-particle duality, Copenhagen errors, Heisenberg uncertainty, red shift, and others. Only the two-way wave exchanges of the WSM match observation.

Even though Einstein had originally proposed the 'photon' he never understood them. In 1954, he wrote to his friend Michael Besso expressing his frustration, "*All these fifty years of conscious brooding have brought me no nearer to the answer to the question, 'What are light quanta? Nowadays every Tom, Dick and Harry thinks he knows it but he is mistaken.'*" Einstein also came to realize that matter could not be described by an electromagnetic field: "*I consider it quite possible that physics cannot be based on the field concept, i.e., on*



continuous structures [discrete particles]. In that case nothing remains of my castle in the air, gravitation theory included". But Einstein was too critical of himself. Although the answer to his light-quanta question had to wait for the WSM, his General Theory of Relativity (gravitation) has survived famously and agrees with the WSM.

THE WISDOM OF ERWIN SCHRÖDINGER. He was a strong supporter of Einstein in the famous debates with Neils Bohr over wave-particle probability. Bohr's Copenhagen group used Schrödinger's famous wave equation to conclude that discrete point particles did exist and the Schrödinger Equation provided the probability of the location of a particle when you found it but the waves were not real. This concept meant that an uncertainty always existed as to where a particle, or anything, was located in this world. Einstein contested this idea strongly stating, "*God does not play dice.*"

Schrödinger of course also disagreed with the Copenhagen group because he had already deduced that discrete particles do not exist; Instead 'particles' were the *appearance* of real wave structures in space, i.e. following the WSM. Accordingly he wrote firmly his opinion of how his equation was interpreted "*Let me say at the outset, that in this discourse, I am opposing not a few special statements of quantum mechanics held today (1950s), I am opposing as it were the whole of it, I am opposing its basic views that have been shaped 25 years ago, when Max Born put forward his probability interpretation, which was accepted by almost everybody. ... I don't like it, and I'm sorry I ever had anything to do with it.*" (Erwin Schrödinger, *Life and Thought*, Cambridge U. Press, 1989). History shows that the physics community has ignored these beliefs of Einstein and Schrödinger. Why they were ignored is another interesting story discussed in the History Chapter and the Chapter – 'Scientists are Human Too'.

ENERGY-EXCHANGE BY AN ELECTRON. The answer to a question like "What is the Electron?" logically requires that the answer explain the origin of the **properties** of the electron. Especially, the fundamentally important *energy-exchange* underlying the concepts of mass and *charge* that are the main properties of the electron. It is important to realize that both 'charge' and 'mass' are merely constants in formulas that describe the energy-exchange (force) taking place when the electron is moved. Thus to explain the electron's properties demands absolutely that the energy-exchange mechanism be explained. Sadly, most authors today don't even mention 'energy-exchange.'

This is very strange since most of them must have taught Physics 101 at some time in their life and have written the definition of force = $F = dE/dx$ pointing out to students that dE/dx is the rate of energy exchange. It is easy to forget!

SECTION III ENERGY & THE STRUCTURE OF PARTICLES AND MOLECULES

HOW TO BUILD A MOLECULE OF WAVES OF ENERGY. In order to describe how an atom or molecule is put together of waves we need to know how the waves are assembled. We already know the electron as the simplest wave structure. To be complete we must learn about the two nuclear resonances, a proton and a neutron as well. In the search, keep in mind that each



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atom or molecule is a stable wave structure that obeys the rules of waves and the MAP. Each part of it is in balance with the whole wave structure and there is no other arrangement that will produce the observed minimum amplitudes of the structure. Also note that the relations between mass, frequency, and energy, or $E=mc^2=hf$ are clearly a result of the wave structure. If one uses the discrete particle notion, there is an unsolvable puzzle as to where the mass 'substance' comes from. Consider the two nucleons: proton and neutron.

NUCLEAR RESONANCES: THE SAME SPACE BUT A DIFFERENT

RESONANCE. Finding the exact solution of the wave equation – Principle I – to form a nucleon, is mathematically very difficult because the medium density is not constant. It is an exciting task that we hope will be done by a mathematical physicist reader of this book. In the meantime we will deduce an approximate geometric model that fits the experimental data as follows:

The proton nuclear resonance is located at the dense center of a positron resonance that is the mirror image of an electron resonance. Conversely an anti-nucleon would be a mirror image of the nucleon. (See the section on CPT rules). We already know the structure of the positron/electron resonances. The dense wave-center is a non-linear region, so it behaves like a transparent sphere with a high index of refraction that guides light waves inside in a circulating mode. The quantum waves follow the same rules as optics and their circulation at the wave center provides the nucleon properties as wave resonances unique to the two nucleons. Can we deduce the general form of the nucleon waves?

No experimental evidence indicates spherical symmetry of the proton nucleus, so space waves circulating like a 'doughnut' inside the sphere are OK. The medium density is large, thus the wavelength will be very small and the velocity and frequency will be large. The frequency must be 1840 times the electron frequency = the ratio of the mass of the proton and the electron. The mass-frequency will have a precise value since circulating waves are standing waves that must repeat themselves at a precise wavelength. Thus a proton is composed of a + charge resonance with a much higher frequency standing resonance at its center.

An important help in this model is the behavior of spin that appears in every resonance due to the transformation of the in-wave to an out-wave at the nuclear resonance center as well as in the electron resonance. Spin is described in the Spin Chapter. Knowledge of spin that occurs in wave resonances is very valuable for modeling.

This approximate model is qualitative. It would be much better to investigate nuclear structure and forces by calculating possible resonant modes using the space resonance wave equation. This calculation is very difficult for the dense non-homogeneous wave media at the wave center. Unfortunately, we authors are mediocre mathematicians, but hope that a clever mathematician will attempt this interesting but difficult challenge. Perhaps a computer program can do it. However we can deduce a lot using the MAP Principle III and knowledge of spin behavior of the in-out waves in every resonance.



Let's compare this model with measured nuclear forces. We know many experimental facts about how neutrons and protons behave together that will help us. There are large forces attracting pairs of them together, especially one neutron and one proton. The tightest bound configuration is two such pairs that form a helium nucleus He^4 . The binding energy per He^4 nucleon is about 20 MeV, compared to about 6 MeV for the average nucleon of an average atom. Proton-neutron binding force occurs because of the alignment of nucleon spins. The spins allow a maximum of four nucleons in the closest possible configuration; More than four creates duplication and annihilation. Now compare this approximate nuclear space-resonance with experimental data:

First, suppose two circulating nuclear resonances were superimposed, what would happen according to the MAP? The amplitudes would interfere either constructively or opposing depending on whether the circulation was the same or opposite. The MAP would cause strong forces to retain the opposing amplitude configuration because amplitudes would be minimum. So we can speculate that two aligned doughnuts can do this if their waves circulate in opposing configurations. Conversely, if one doughnut were flipped, there would be additive amplitudes and force between them would be repulsive so this configuration won't happen. (Remember, the two doughnuts have the same axis and occupy the same space). Two protons or two neutrons cannot be together because in the amplitude-canceling mode they would annihilate and in the other alignment, they are repulsive. We deduce that only one neutron-proton pair can be together. So, one pair becomes a deuteron, and two pairs are He^4 . This agrees with experiment. Both are known to be stable and the He^4 atom is the most stable.

Consider how the forces between nucleons change with distance. It is experimentally known that if two nucleons are separated by more than about c^2/mc^2 , about 10^{-15} meter, the attractive forces quickly disappear. We note that this matches the distance calculated by the Equation of the Cosmos (See chapter on Cosmology) where non-linearity of space begins for space resonances. This is approximately the diameter of nuclear space resonances. So if the nuclear resonances are separated past this distance, their wave overlap falls off quickly, there is no energy transfer, and force approaches zero. So, again this doughnut nuclear resonance model agrees with experiment.

THE UNSTABLE PARTICLE ZOO. How does the nuclear space resonance explain the zoo of hi-energy nuclear particles (hadrons) that have properties similar to a proton except their masses are larger? All of these particles are known to decay quickly into a proton in 10^{-10} to 10^{-26} seconds. This suggests that the nuclear space resonance has higher energy modes of shorter wavelength, as is commonly found in other natural resonances. Thus the zoo is qualitatively understood.

We see that the proton is the mode of lowest possible mass-frequency, hence it is stable. The more massive particles are the higher modes with higher frequencies and depending on the mode, have different values of other parameters such as spin. They are unstable because there is lower amplitude to which they can, decay, via the MAP, into a proton. The large density of



waves at the center guarantees a large coupling between resonances so the energy-exchanges are very quick (10^{-10} to 10^{-20} seconds), thus explaining the short lifetimes, compared to atomic lifetimes of 10^{-8} second. Exclusion principles would be expected to exist because of dis-similar geometries (orthogonal modes) thus explaining the slower decays. All these interesting possibilities could be confirmed or de-firmed by solving the SR wave equation! Who will do it?

Another interesting problem with a valuable result is to see if a way can be found to match up nuclear space resonances with the group-theory explanation of the nuclear particle zoo. One such theory is the *Eight-fold Way* discovered by Gell-Mann and Ne'man in 1960. It cleverly uses geometric groupings of the various particles to diagram their parameters: spin, parity, isotope number, and strangeness number. The group theory of the Eight-fold Way cannot reveal a physical structure as long as it assumes discrete particles; they have no structure. But it is logical to expect that solutions of the Wave Equation would have orthogonal wave structures that do match the Eight-fold Way. An exciting prospect is to attempt a complete calculation.

There is another discrete-particle concept about nuclear forces that posits a mathematical particle called a gluon. The hypothetical gluon transfers energy between nucleons and other baryons like the photon between electrons. However theorists are puzzled that a gluon has never been observed in any particle detector. But if you interpret it using the space resonance concept it is not puzzling, because the gluon, like the photon is not particulate. It is only modulation of the space waves traveling between the two nucleons. Clearly it makes no sense to expect this modulation anywhere except between the two nucleons involved.

THE WEAK NUCLEAR FORCE: THE SAME RESONANCE BUT A DIFFERENT SPACE. The weak Force is a term describing the very slow decay and split-up of some baryons into lower energy particles. The most common example is the decay of a free neutron into a proton plus an electron, together with transfer of energy and momentum to other particles. The lifetime is about 14 minutes.

The key clue that reveals the weak-force mechanism is that energy is transferred outside of the initial baryon. For this reason, the distance between exchanging nuclear resonances is large compared to nuclear distances. The distance of an exchange from inside a nucleus to another particle outside the nucleus is many times larger than the nuclear central region. The nearest outside nucleon might be in an adjacent atomic lattice perhaps one micron (10^{-6} m) away. This is about 10^9 nuclear diameters distant! Thus the overlap of the wave amplitude of the central nuclear resonance with waves of particles outside is miniscule. Accordingly the coupling between them is tiny and the decay is expected to be extremely slow compared to energy transfer times within one nucleus. Experimentally this is the case; typical decay times are 10^{22} times slower. Likewise, the amount of energy exchanged is small. Thus the WSM space-resonance of nucleon agrees qualitatively with experiment.



AN EXPERIMENT TO VERIFY WSM ENERGY TRANSFER. It is possible to experimentally verify the WSM origin of weak forces because it predicts that decay times depend on the coupling between two resonances which vary depending on the types of resonances and the distance between them. The classical concept of weak decay assumes and predicts that decay times are fixed because they are an intrinsic property of the decaying particle. Thus the WSM can be verified by an experiment to measure the decay time of a neutron located in outer space on a satellite distant from any matter. The time is about 14 minutes on Earth, but should become much longer, if distant from other matter.

THE FINAL FRONTIER – WHAT IS THE ORIGIN AND COMPOSITION OF THE ENERGY-SPACE? Because the energy-space is the origin and medium of the waves that constitute matter, as well as the natural laws that govern matter, all the questions of physics are answered in principle, except: What is the energy-medium of space itself? We see no obvious answer to this – It is the final question of the Universe. We would like to know what kind of a thing space is. Especially how does the feedback loop of the universe occur that is discussed in the Cosmology Chapter: i.e. *The matter of the Universe tells space what it is and space tells matter how it must behave.* This same feedback loop is seen in the Theory of General Relativity, expressed on an astronomical scale. Thus Space and matter, each depends on the other. Why? How? This is very strange.

We can deduce that the energy density of (quantum) space is extremely large. In particular, in order that the wave density of a nuclear resonance matches the measured energy density of a nucleon, the space energy density must be very large. The whole of space must have a density exceeding that of a nucleon – breathtaking! And yet we are unaware of it except when energy transfers occur. Again, our perspective is limited, just like the fish that cannot understand the meaning of water.

CHAPTER NINE

SCIENTISTS ARE HUMAN TOO: THE PROCESS OF FINDING KNOWLEDGE

- I. Pitfalls on the Path to Finding Scientific Knowledge
- II. The Methods of Finding Scientific Knowledge

"A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it."

– Max Planck



SECTION I PITFALLS ON THE PATH TO FINDING SCIENTIFIC KNOWLEDGE

If we want to correctly understand natural science, we must be very careful to check the entire process of acquiring knowledge from the beginning to the end. Measurement is the beginning. Discovery of Nature is the end. There are many pitfalls in between. Let us take a short look at the process and the pitfalls of finding knowledge in the Quantum and Cosmos realms of our Universe.

SCIENTISTS SEEK SURVIVAL IN A HOSTILE WORLD. Science in its historical development has frequently been distorted and wrongly conceived. This happens for many reasons. Prominent among them are the social and political pressures placed upon the scientific community by those persons who control the rewards, positions, and promotions that the scientist must have to survive. Often, the scientists themselves desire wealth and power, as well as engineering, economic, and human convenience in their work and lives. Another extremely important bias of science is that the conclusions of science are always more comfortable if they agree with the human day-to-day perspectives of space, time, and our familiar surroundings - truth notwithstanding. Not infrequently there are benefits to authors of distortion who are simply attending to their own survival in an academic or economic rat-race. Such distortions can take the form of merely a different choice of terms or emphasis in their writing, to an extreme form of outright manufacturing of the facts. The latter is not important in the long run for they are usually found and corrected.

Although science exists to seek out new knowledge, discoveries which conflict with popular notions are not warmly received by the churches, scientific establishments, or the governments in power. Kepler was accused of occultism when he suggested the Moon controls the tides. Copernicus was excommunicated by the church for teaching that the Sun was the center of a Solar System, and Giordano Bruno was burned at the stake. This letter to Kepler from Galileo says a lot: *I wish, my dear Kepler, that we could have a good laugh together at the extraordinary stupidity of the mob. What do you think of the foremost philosophers of this University? In spite of my oft-repeated efforts and invitations, they have refused, with the obstinacy of a gluttonous adder, to look at the planets or Moon or my telescope. (Galileo Galilei).*

This still happens today. As recently as 1960, I watched the now-famous author of the plate tectonic theory of Earth crust movement being ridiculed in his lecture at Harvard University when he stated that South America was once attached to Africa. Only 20 to 30 years ago, the inventor, L. Ovshinsky, of amorphous semi-conductors (non-crystalline silicon) was said to be a "crazy uneducated weirdo" because he was a self-educated scientist and not part of an academic group. His idea was proclaimed "impossible". But later he headed an \$800 million dollar NYSE corporation making amorphous semi-conductors. He has been quoted, "You can always tell a pioneer by the arrows in his back." On the other hand, not every dissident idea is likely to be correct. As implied by the fabled Murphy's Law "If it can go wrong, it will go wrong." Scientific truth has only a few ways to be expressed correctly, but

there are thousands of ways to express it wrongly! It is easy to take the wrong paths that are numerous, and difficult to find the few right ones.

There is an important concept to be learned here and I think it is not sufficient to merely agree that various scientific errors do occur, because you the reader are apt to say, "Oh yes, that happens of course. But it won't happen to me because I am a very careful logical thinker and I am very honest with my own thoughts." There is the trap! A person hopes and imagines that he is immune if he chooses to be. But the most insidious of scientific errors are those we cannot recognize because they are ingrained into our emotional thinking, as a result of our human realm environment, or because they are accepted dogma of the scientific community, or because the errors have been historically knit into the fabric of scientific subject matter.

As the decades pass, science has to be revised from time to time, correcting errors of historical perspective. The rectification process is usually not just a matter of correcting a number, rephrasing a principle, or adding another term to an equation. Instead, whole concepts may have to be revised. The process can be quite unpleasant if a new concept forces you to give up a favorite idea or makes obsolete your published book which has enhanced your reputation and is now paying you royalties, or you lose your research grant. Most old scientists are likely to fight the new concept, tooth and nail! And who can really blame them; they are after all only human. This is the situation of the new Wave Structure of Matter (WSM). It is simple, proven and immensely valuable because it is the origin of the natural laws of physics. But it conflicts with the old embedded notion of the point material particle and the economic and scientific culture that has grown up around it. It is important to understand this conflict in order to obtain future benefits for science and technology. Past conflicts have already been elegantly described by Thomas Kuhn of MIT in his book "The Structure of Scientific Revolutions". Present and future conflicts may be similar.

THE NEED FOR LOGIC AND REASON IN SCIENCE. Beginning in the fifth century B.C., known as the golden age of Greek mathematics, the philosopher-mathematicians with familiar names like Euclid, Archimedes, and Pythagorus, believed that pure human reason was capable of deducing the secrets of Nature. However history has shown that although their method was immensely productive of algebra and geometry, their progress in natural philosophy (physics) was very slight. Instead, knowledge of the natural world arose from the work of persons who measured natural events. These persons frequently were architects, engineers, and weapons-makers, like Leonardo De Vinci, Galileo and Count Rumford, who sought to understand natural law in order to design buildings and machines. When they were wrong, the machines didn't work, or the buildings fell down. True and false became very apparent instead of philosophical.

Formal recognition that science had to be based upon measurement began with Kepler, Galileo and Newton in the seventeenth century, and became known as the scientific method. Nevertheless, human emotions continue to persuade us that pure logic and reason can reveal Nature's intentions. A



famous and unfortunate example today is the notion of the material point particle as the element of matter - proposed by Democritus. It has plagued science for several thousand years.

The failures of human intuition in mathematics and physics, has led to a tightening of the rules of logic used by mathematicians. These efforts, in the work of Kurt Goedel (1906-1978), led to a strange result: Mathematics cannot prove that mathematics is correct! Goedel showed that the axiomatic method of mathematics has inherent limitations to find truth. He proved that the method of axiomatic arithmetic is incomplete; that is, given any set of axioms, there will always exist true arithmetical statements that cannot be derived from the given set. Further it is not possible to prove that a system of arithmetic is self-consistent. We are left with very uncomfortable feelings about our capability to be absolutely sure of anything. In the famous words of Bertrand Russell, "*Pure mathematics is the subject in which we do not know what we are talking about, nor whether what we are saying is true.*"

One of the beautiful branches of mathematics is symmetry and group theory. Examples of symmetry in nature, art, and geometry are breathtakingly beautiful. We can stand in awe of biological mechanisms that produce symmetries and the skill of the artists who draw them. The mathematician finds a wealth of knowledge and applications that can arise from a few simple propositions of group theory. Prominent are the special properties of three-dimensional space that turns out to underlie the rules of matter, physics, and the universe. A unique 3D property is that a converging spherical wave can change to a diverging wave by a property termed '*spherical rotation*' in which the wave rotates exactly two times during the change. This results in the quantum *spin* of 'particles' - to be discussed later. Suffice it to say that if this geometry property of 3D space did not exist: matter, life, and ourselves as we know them could not exist.

THINK QUANTUM - THINK COSMOS - FREED FROM THE HUMAN REALM

A powerful bias, common in 20th century science, which tends to lead us in the wrong direction, is the fact that we live and think in the human realm located here on Earth, whereas the problems we want to investigate lie in the quantum and cosmos realms. Two hundred years of science with no thought of quantum waves or the cosmos have spawned attitudes and assumptions of a world occupied by solid particles, Euclidian geometry, and preconceived notions of length, time and mass. How are we to escape this psychological prison?

One way is to be very skeptical and selective about which facts one believes and trusts. Since it is Nature we are investigating, we must be sure that each fact we use is the actual result of a measurement of Nature. Whenever we examine a particular arena of science, all its background knowledge should be surveyed to check that no extraneous ideas have been added which interfere with the logical path of future exploration. We must not allow ourselves to extrapolate unreasonably beyond what has been actually measured.

From time to time we need go back into the garden of cultivated science and weed out old ideas that are no longer valid. For example, the notions of

electric and magnetic fields were created more than one hundred years ago as a mental crutch to explain action at a distance. The fields are imaginary things, still useful as mathematical symbols and words that make engineering easier but they confuse our thinking when we seek the basic causes of electric phenomena.

SECTION I

SECTION II THE METHODS OF FINDING SCIENTIFIC KNOWLEDGE

THE IMPORTANCE OF UNDERSTANDING MEASUREMENTS. In our search for truth we must carefully understand the meaning of measurements so that we can understand Nature. It will never be possible for any one person to repeat all of the experimental measurements that have been made at the frontier but it is essential that we be sure of the facts that they indicate according to their authors. We know that errors and invalid assumptions continually seep into the textbooks of science, and a means must be established to find and weed them out. One feasible method is to read the original accounts of the experimental work and apply critical judgment to them. A brief review here of some of the more important types of measurements will be useful.

In the human realm, you are already familiar with the kinds of measurements that can be made, so there is no need to describe most of them. The measurements that concern us most are those which affect the quantum realm and the cosmos realm, because we have no ordinary experience to guide our interpretation or check our results.

Quantum Realm Measurements. There are two kinds of measurements from which most of our knowledge has been obtained. These are: optical and other spectra, and particle tracks on film or in cloud chambers.

When we observe the optical spectrum of say a colored light source, we measure the energy (frequency) difference between the initial energy state of the source atoms before they radiate, and their final state after radiation. It is important to notice that large numbers of identical atoms are changing state so that large numbers of identical images are recorded on the film. The energy exchange is described by the equation,

$$\text{Energy exchange} = E_1 - E_2 = hf$$

Where E_1 and E_2 are initial and final energies of a molecular state, f is the frequency of the spectra emitted, and the amount of energy change is hf , which is termed one quantum. The various means used to bring about the frequency change are of great interest, for it is often the central feature of the experiment. For example, a magnetic or an electric field can be applied to the molecules or atoms, or they may be bombarded with other atoms. The energy exchanges that occur are of paramount importance.



Photographs of 'particle' tracks on film or in cloud chambers are themselves a series of small energy transfers to the film or cloud along the path followed by the 'particle'. The path shape itself indicates the size of the energy transfer. We can deduce the kinetic energy/momentum and charge of the 'particle' if there is a magnetic field present that curves the path. Each measurement is the result of an energy exchange (or the equivalent, a frequency change). All information from measurement requires an energy exchange for that is what information is. Other properties, such as momentum or charge may be adduced by calculation and inference. To make the inference requires added assumptions concerning the relationship between energy change actually measured and the value of the variable adduced. In the human realm, we are confident of these assumptions, but in the quantum realm, a degree of uncertainty exists. What is really happening?

DO WE KNOW THE LAWS OF THE COSMOS? Measurements in the cosmos realm are usually light (frequency changes) because radiation from other stars is practically the only means we have of learning about distant regions of space. Most measurements are due to many exchanges recorded on photographic film, although in the last decade single energy exchanges are measured using very sensitive charge-coupled detectors (CCD). In the cosmos we seldom face the problems of strange quantum behavior, but there is a new uncertainty. We do not know if the laws of physics found on Earth are also identical in the distant regions of space. This problem has four faces:

Firstly, the radiation from anti-matter has been deeply considered and it appears that we are unable to determine whether a galaxy is matter or anti-matter. The radiations from either are identical. Second, there is no way to know whether or not the numerical constants of physics are the same as here on Earth. Within our own Solar system, spacecraft measurements have found such constants to be the same. And within our own galaxy, the evidence is strong that anti-matter is rare. Beyond these limits, there is only knowledge of a general sort, that the laws of physics are at least similar.

Second, radiation from the distant regions requires a substantial time to arrive. Further the inter-dependence between all the matter (wave-centers) of the universe become dominant at large distances and changes the observed properties of radiation and of the wave medium (space). This means we are unable to know what is happening "now", but only learn what had happened "then" at earlier times. Although the amplitudes of waves mathematically extend to infinity, we cannot make such measurements in finite time. This can change the appearance and dimensions of the cosmos. See the chapter on Cosmology.

Thirdly, the structure of distant matter (wave centers) can only be ascertained by energy exchanges from there to here. However the intervening matter (wave centers) is increasingly involved in the exchange process, so that the appearance of exchanges from distant matter may be changed in ways that are not yet fully explored. Especially it is to be expected that distant radiation would *appear* to have less energy. That is, wavelength would be increased even though the distant matter was no different than similar matter on Earth.

Fourth, the fact that the mass of us and the Earth are such a miniscule fraction of the entire Universe: a billion x billion x billion x billion times larger. Thus it is difficult to believe that the laws of Nature are unique here on Earth, or any different than laws out there. We have already concluded, as did the Greek philosophers, that one thing (*space*) must underlie the laws everywhere. And using the Principles of the Wave Structure of Matter and General Relativity, we conclude that *space* is nearly the same everywhere. Why should it be different? This means that the Laws of Nature are a property of all the Universe, not the laws (rules) of Earth that we have created here.

But the astronomers and astronauts do have one firm advantage over quantum physicists in their work. The cosmos provides them with three-dimensional information obtained from the shapes of images on photographs. Thus we can learn the 3D geometry of cosmos objects. This is a valuable and different feature of cosmic measurements, often not found in quantum realm work.

THE PROBLEMS OF READING SCIENCE. When seeking to learn about science by reading articles and books, it is important to be wary of the motive of the authors. Some authors of scientific articles are theoreticians only, their goals in science are often merely to get 'published' - a necessity for promotion in their job. They provide correct algebra, but without logic and meaning in their pages. The deep committed urge to understand Nature, found in great authors, is often not there.

In contrast, when trying to understand the Universe, it is important to consider carefully the proposals and thinking of men like Einstein, Schrödinger, Clifford, deBroglie, and Dirac. who were greatly concerned with the matter and structure of the Universe. These famous men were major contributors to the knowledge of the electron and space that dominates the Universe.

LOGICAL REASONING. There is a simple logical truth that: *one cannot use circular reasoning*; i.e. use what you are trying to explain within the explanation itself. For example, you cannot use 'charge' to explain what 'charge' is! Thus models of the electron that include 'sheets of charge' or 'rings of charge' are doomed to failure. The same is true for models of spin using mechanical 'toy tops'. This error was common in the early 1900s by some famous authors, but today some authors still repeat the errors that 'charge' and 'mass' are substances! We humans are as prey to human emotions today as we have always been. This is why the proposals of Clifford, Einstein, and Schrödinger were so brilliant - they made it clear that these properties of matter, charge and mass, lay in the structure of the waves of matter in space. They were clear thinkers and invoked no charge and mass substances. They probed the basic truth of matter, and were the precursors of the Wave Structure of Matter - the subject of this book.

This theory of the WSM is not going to be accepted immediately by the mainstream. This does not mean it is wrong, "*Right does not cease to be right because the majority do not share in it*" (Tolstoy). The WSM has already been spurned by the mainstream journal *Physical Review* but it is published



by journals that envision the future; like Temple University's Frontier Perspectives. And it is described in the world's largest encyclopedia – the Internet Wikipedia. On the practical side, Intel Corporation in Silicon Valley has funded a chair for Prof. Carver Meade of Cal-Tech who used the WSM to correct ancient errors of magnetism that are needed for micro-chip manufacture. Meade views the mainstream like the professors of Galileo who refused to look into his telescope. Meade wrote: "*History will view the last seven decades of the 20th century as the dark ages of theoretical physics.*" See his book *Collective Electrodynamics* (1999).

TEN

THE SIMPLICITY OF THE WAVE STRUCTURE

- I. The Simplicity of Nature's Universe
- II. Simplicity of the Attributes of the Universe
- III. The Inter-dependence of Laws, Particles
and the Universe

*If the stars in the heavens were not there, we could not exist.
Nature is an interconnected Universe.*



SECTION I THE SIMPLICITY OF NATURE'S UNIVERSE

Some readers prefer to view the Universe in terms of concepts because it is the basis of innovative thinking. For them, we have written conceptual descriptions below, of the Wave Structure of Matter (WSM). Simplicity is found in the beauty of space and motion and especially in the Wave Structure of Matter. Nature has created in the WSM a way to build the enormous complexity of atoms, molecules, chemistry and life, and yet begin with a single substance on Nature's palette – *space*.

The philosophical studies of this Section are the innovative work of Geoff Haselhurst.

ONE SUBSTANCE. Ancient Greek and modern European thinkers had long ago concluded that all the material of the Universe should be derived from *one* substance. This was the result of an enigma: How can you explain the enormous variety of materials found on Earth? Centuries ago this enigma often became known as 'God'. But the Greeks considered the mathematics of probability and concluded it was impossible that there could be an enormous variety of explanations; there had to be just one explanation. In other words there should be *one* thing that is the cause of all other things. What is it?

THE SOLUTION is to first understand what the One thing might be and then to show that it can produce all the necessary attributes of matter that we find on Earth and in the Universe. In previous chapters, we saw that Einstein realized and provided arguments to show that "*Space is one infinite and eternal thing. Space as a wave medium has always existed.*" We can further deduce that a second thing, an attribute of the one substance, is needed to explain Nature; this is *Motion*. It is probable that only Clifford, Schrödinger, and Dirac realized that waves in a space medium fulfill these two requirements. But both Newton and Galileo recognized the fundamental importance of motion. You the reader might have also have realized this! No one provided a concrete method of calculating the motion and structure of waves in a *space* medium, leaving the mathematics and proof to Wolff (1990) and this new book.

Motion is a property of the spherical wave structures of matter. Thus motion of waves in space is necessary for matter to exist in space. Motion explains:

- 1) How matter can interact with all other matter in the Universe due to properties of the spherical inward and outward waves.
- 2) How matter appears as a particle - the wave-center of spherical waves.
- 3) How one object can transfer energy to another:

Energy exchange is a resonant coupling between two electrons or wave-centers. Musicians understand this immediately – one wave center decreases in amplitude (energy), the other increases. And if the musician is a physicist, *he* she realizes the exchanges are equal and opposite fulfilling the conservation of energy. Light is the same except that our eyes are the energy receiver. Is it

too much to ask that readers combine the skills of an astronomer, a musician, and a physicist, to solve these puzzles of the past? That done, there is still a future to unravel. Simplicity is valuable!

MOTION AND TIME. How is the motion of waves in space able to provide *time* as we know it? Here is a nice simple example. Imagine a pendulum clock but the pendulum is not moving, thus the clock does not measure time. What can we add to this clock, such that it is still the same one clock but also keeps time? Obviously it is Motion - We can swing the pendulum. We now notice that the concept of Time is tied to the Motion; when motion exists the clock starts to work measuring time. The main ingredient of a frequency is a repetitive wave motion analogous to the pendulum clock. In short, time requires motion.

SPACE AND TIME. These two words together imply a special meaning begun by Einstein: His initial meaning was not a wave medium, but that the dimension of time and the 3D dimensions of length, together describe the position of an object. These dimensions are also essential for all the measurements of science because just these measuring units: time, and three dimensions of length are required. Any description of the Earth, or the Universe, must include them.

This also clarifies Einstein's view of the Universe - Einstein used these elements: space, time and a density of space, in order to calculate his General Relativity Theory (GTR). GTR first calculates density. After finding a density of space in any particular location, dependent on the location of all matter in all of space using a six dimensional calculation, GTR proceeds to find the motion of desired objects in any particular location of space.

The general results of the GTR can be explained simpler with Space and Motion of waves by using the Wave Structure of Matter. Using the space and wave-motion of the WSM, we only need the ordinary view of geometry we are already familiar with. Principle II of the WSM finds space density using a 3D calculation - In fact, only 1D, a radius, is needed if you assume that the Universe is spherically symmetrical. The WSM makes it easy to understand gravity. Near an object like the Sun, its matter causes a small change of the very large local space density due to the rest of the matter of the Universe. This small density change produces what we call gravity. The path of a light ray follows the local density. Thus we deduce that light paths are curved by gravity near the Sun - just as we observe it.

Einstein's GTR approach uses different terms. GTR calculates the *curvature* of space-time near the attracting body, and then instead of curving the light paths, he argued that light traveled a '*straight*' path in a '*curved space-time*'. His view and the WSM are mathematically equivalent since it is the change of density of space that causes this curvature in either case. The changed motion of matter is interpreted as the force of gravity. Thus the curvature of Einstein's 4D Space-Time continuum, is equivalent in the WSM, to a change in velocity of spherical waves near other matter.



HOW DO THE PROPERTIES OF SPACE CAUSE GRAVITY? Gravity is an example of how simple thinking can find correct results without much math. For example, ever since Newton deduced his rule to calculate gravity forces, scientists and astronomers have sought to understand how gravity works. There were dozens of proposals and experiments. None succeeded in providing understanding of gravity. In hindsight we know why; they used the incorrect mass particle model of matter instead of Nature's wave structure. With the right structure of matter you can find the answer simply by asking the right question: *What happens to the IN-OUT waves of an electron when passing near an attracting body, like the Sun?*

The answer is: The in-waves are slowed down as they flow near the matter of the Sun, the attracting body. This is because the Sun's own waves have slightly increased the density of space around it. The velocity of waves of light, change when space is more dense. Since we observe the position of matter as the wave-center of the waves, we will see the wave-center move toward the attracting body. This motion is gravity.

If you are like Newton who said "*I always think about problems first and then calculate them afterwards*", you should calculate to find out if this in-wave deduction works. These ideas are discussed further in the chapters on History and Astronomy.

THE SIMPLEST THING IS THE ELECTRON. The philosophical elegance of the electron itself is its simplicity: Just two waves. Everything remains in three normal dimensions.. Joining simple electrons and protons produces the wave structure of molecules that form the complexity of life and matter on Earth. The spherical wave structure produces myriad combinations of standing wave structures, the crystalline matter of the physical universe. The wave arrays of crystals might appear like rows of shimmering bubbles if you could 'see' them, which you cannot, because quantum waves are not electromagnetic. Living matter is more complex; combinations of wave structures are held together by the general principle MAP that always chooses the minimum, and thus the simplest, amplitudes of the waves.

MORE SIMPLE QUESTIONS ABOUT THE UNIVERSE. Astronomers have often sought relationships between the macroscopic world and the vast universe. Until recently, before large telescopes and technology were capable of deep-space investigation, Earth-bound astronomers felt they had no knowledge to find those relationships. But by asking relatively simple questions, geometry alone without the telescopes can provide surprising correct answers. Let's ask:

Where is the universal clock of time?

How are the units of length, established and communicated between particles?

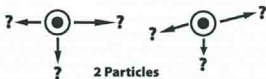
What information (length units) do particles use to communicate their location?

The answers reveal important properties of the Universe. The answer to the clock question is easy: Particles must be an oscillating wave structure whose frequency (the clock) is a property of the space medium. This is just what



the electron is: an oscillator or a clock. Then, because space density is nearly constant everywhere, the clocks of the matter in space everywhere are nearly the same.

Imagine two particles out in space:



An example, natural law states the following:

$$\text{Force} = \frac{(\text{property 1}) \times (\text{property 2}) \times \text{vector}}{(\text{separation})^2}$$

$$= \text{mass} \times \text{acceleration}$$

How is each particle able to carry out the law?

Think about the other questions by considering two particles in space, Figure 10.1. We know they will obey natural laws interacting with each other. Now the critical question arises: How are measures of the space-time *dimensions* established and communicated between two particles? The particles have to 'know' the dimensions in order to follow the laws. That is, when two particles attract each other, some agent or process must measure the distance between them, establish the force law, and inform or guide each particle to the vector of acceleration it must undergo. We know that the laws they follow will involve the *dimensions of time, length, and mass*. We know this happens and we want to find out how and why it happens.

We must find the method of *distance measurement*: What is the distance scale used by the particles themselves to measure their separation? We know right away that if no other matter existed, *distance* scales would be meaningless since size and distance are relative measures of an object. Furthermore, every particle must have access to the *same* distance scale, otherwise interactions would be chaotic, not the orderly laws we observe, obeyed by all particles. Thus we deduce beyond any doubt that the distance scale and the laws that use it *must depend on other matter* and its distribution in space.

The same situation applies to *time*. Every particle, however separated, has to have access to the same clock in order to carry out the orderly rules of law in the cosmos. Above we already deduced that the electron was the universal clock. But we also want to know how time is communicated among all particles? They cannot behave independently! All must use an identical time scale. Incidentally, we should remember that since $E=hf=mc^2$, we only need to establish the one unit of *time*: The other two, *frequency*, or *mass*, follow from this equation.

SECTION I

Figure 10.1.
Force laws. What mechanism finds the location of the particles? How is the separation measured? What time scale is to be used? The two particles know nothing of metric scales but nevertheless move toward each other obeying a law. The mechanism of how this law occurs reveals how the waves of the Nature create the laws of physics (particle motion) and the clocks and scales of time and length everywhere.

SECTION I

TIME, COMMUNICATION, AND THE UNIVERSE. Since we know the electron structure, we can deduce that the cosmological clock, the frequency of the electron waves, is a property of the space medium. But since the space medium is the same nearly everywhere, the clocks and the waves are the same everywhere. Thus it the universal wave medium that gives us an orderly Universe. This is the answer to the questions.

The waves in the medium also perform the role of communication. Not only *time* but other dimensions, *length and mass*, depend on the medium. So these too are the same everywhere. The meaning of *length* boils down to the wavelength of the atomic oscillators such as the electron; this is how length standards are established in the science labs. The meaning of mass m is the same as frequency f , from $hf=mc^2$, and these too can be measured in the lab using frequency.

The wave medium of space has been very helpful in telling us why there is an orderly Universe and why things are what they are. It happens this way because the medium itself is a consequence of all matter everywhere. It appears as Principle II of the WSM. Einstein also used all matter of the Universe as the fundamental basis in the GTR.

The universal wave-medium has been helpful to us in another way. It produced, from Principle II, the *Equation of the Cosmos* (See the chapter on Astronomy and the math appendix). This states that the size of an electron's wave center, is determined by the size of the Hubble Universe. In fact, as we have deduced above, all three: the size of the electron, the size of the Universe, and the medium density are proportional to each other. This interplay of elements of the Universe is a sobering thought.



QUESTION FOR THOUGHT:

WHICH OF THESE THREE: THE ELECTRON, THE UNIVERSE, OR THE MEDIUM, IS REALLY BASIC, I.E. WHICH IS REALLY RUNNING THE SHOW?

SECTION II SIMPLICITY OF THE ATTRIBUTES OF THE UNIVERSE

DEDUCTION OF THE ATTRIBUTES. In this section we want to use simple thinking to learn about the Natural Laws by viewing the past and deducing simple and fundamental attributes of the Universe. By looking back in hindsight, there are new things to deduce and learn about science and the Universe. In the last millennium, our past knowledge of physics had progressed to understanding that objects always obey fixed *laws of nature*: conservation, inertia, electromagnetism, gravity, QM and relativity. Using these laws, we have devised sophisticated technology to aid our survival on Earth: industrial machines, computers, air and spacecraft, and mass production. But before the WSM we lacked understanding of the origin of natural laws and their relationship to cosmology. Now, knowing the origins for the first time, provides an enormous window on the Universe.



Before the WSM some scientists believed, in a religious fashion, that we were not allowed to know the origins of the laws, that we must just accept them given to us by Nature. Still others believed that the natural laws are already complete and to obtain further understanding all we needed to do is mathematically manipulate them to discover their origins.

STUDY THE PUZZLES AND PARADOXES. Curious scientists had noticed that all was not well with the laws. In small ways they failed to predict. They constantly uncovered paradoxes in the realm of micro-particles: They didn't understand what a "photon" is or how "spin" can occur in a spherically-symmetric discrete particle. In some distant galaxies, Newton's laws of gravity and centrifugal momentum seem to go completely awry. These difficulties also led to the need for a Wave Structure of Matter in the minds of Schrödinger long ago, and it was one motivation for this book.

REQUIRED ATTRIBUTES OF THE ENTIRE UNIVERSE. The conclusion is inescapable that the laws of physics are properties of the entire ensemble of matter in a universe. Thus different matter 'particles' in the universe must be inter-dependent. This situation can prevail only if there exists a medium of communication between particles. We can summarize these attributes below.

Attribute 1. *Particles, laws, and the universe are an inter-dependent trilogy. Each demands the existence of the others as in Figure 10.2.*

Attribute 2. *Dimensions are a property of an ensemble of matter.*
A particle entirely alone in the universe could not have dimensions of time, length, or mass because dimensions can only be defined by *comparison* with other matter. For example, at least six separated particles are necessary to crudely define length in a 3D space (four to establish coordinates and two to measure). Thus, *the dimension of length requires the existence of an ensemble of particles.* The required ensemble must include *all* observable matter, for there is no way to choose a special ensemble. *Mass* also requires an ensemble for its meaning. It is defined by its force interaction with other masses. Mass alone is meaningless. The importance of this concept becomes clearer when we recall that time, length and mass are the basic unit set used to describe all scientific measurements.

Attribute 3. *Interacting particles must be aware of each other.*
A force law between two particles cannot operate unless they are aware of each other's presence and location. Accordingly, there exists a means of continual communication between particles in the *space* of the universe of the particles. We have seen that waves from electrons serves to communicate between them.

Attribute 4. *The accessible universe is limited by communication.*
The ensemble of particles that communicate with each other (and with us through our observations) becomes the universe that we can observe. For example, from Earth we can communicate within a radius equal to the range of light traveling from the beginning of our observation. No



meaning can be attached to things or events outside of this range. (See Chapter on Astronomy.) Thus: *An individual universe is defined for each particle as the space and other particles within that space, that are able to communicate with the particle.*

Attribute 5. *The Dimension of Time requires a cosmological clock.*

Adding to the discussion above for the dimension of time, we can conclude that all laws which involve the measurement of time, notably velocity, frequency and mass, cannot operate if particles have no reference of time. That is, the particles must have a way to compare their own time-dependent behavior with other particles. Because all particles obey natural laws, this time reference requires the existence of rhythmic time markers *common to all particles*. That is, a cosmic clock. Space is nearly homogeneous and is common to all particles. Thus the cosmic clock is an oscillator contained in every charged particle structure as suggested by deBroglie. The frequency is a property of space and thus clocks are nearly alike since space, the medium of the waves, is mostly homogeneous.

Attribute 6. *Space has varying properties.*

The variety of matter (objects) in the Universe results in a varying wave medium. If the medium is not exactly uniform the laws are perturbed. For example, light rays bend near the Sun. The Sun's gravitational potential affects the medium of light propagation. The tiny gravity force is caused by in-homogeneities of space near massive bodies. We deduce that: *The laws of matter depend on the properties of the communication medium (space) within the universe.*

Attribute 7. *Mach's Principle.*

The only possible reference for changing motion (acceleration or rotation) is the entire ensemble of matter in a universe. The first person to state this was Ernst Mach in 1883. Mach boldly suggested that inertia depends upon the existence of the distant stars. Mach reasoned that there must be a causal connection between the distant matter in the universe and inertia.

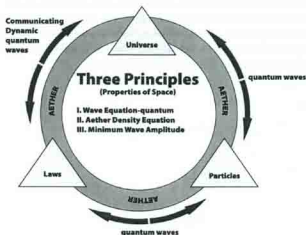
Attribute 8. *All the laws of physics depend on the properties of space.*

Mach's Principle implies that other properties of space are determined by all matter in it. Substantial evidence exists: The rigidity of solid crystals derive from the rigidity of the quantum wave space. Einstein's general theory of relativity and curvature of light rays depend on space. Electromagnetic constants and motion of light beams derive from constants of space (indices of refraction). Thus the spectrum of laws, microphysics to cosmology, depends upon all matter of the universe.

USING THE ATTRIBUTES. These attributes can be used to test models of Nature and their proposed relationships with cosmology through agreement with the attributes. The point-mass particle model of Democritus fails miserably! In fact, all particle models composed of static charge or mass substance

must fail because they have no time reference or communication. But the basic rules of quantum mechanics do not conflict with these attributes. This is true because QM does not depend on a belief in particles, or mass substance, or charge substance. The belief in particulate substances is popular today using Bohr's Copenhagen concept with point-mass particles but fails this test of logic. In contrast Clifford's wave concept and Schrödinger's and deBroglie's all-wave interpretation of QM (See Moore, 1989) pass the test.

THE MEANING OF LAWS, PARTICLES, AND UNIVERSE. We can broaden our analytic perspective of cosmology by recognizing that the three words: *Universe, natural laws and particles*, are interdependent. First, our meaning of the word *Universe* is a collection of particles. Accordingly, understanding our Universe depends on understanding the particles in it. Second, the natural laws are meaningless without particles because laws require particles or objects upon which to operate. The converse is also true; We cannot identify a particle and its properties without the force laws to locate and measure it. Thus these three: the Universe, particles and laws are an inter-dependent trilogy. This is not speculation but hard fact based upon the meaning of the words we use to describe cosmology. Examine this trilogy further by a peek at Figure 10.2 that illustrates these conclusions.



TWO VIEWS OF OUR UNIVERSE. There are two views (interpretations) of the physical behavior of matter. We see one large-scale view as our familiar 3D environment, governed by the Natural Laws. We see it with five senses and their extensions, laboratory instruments. Light and heat (electromagnetic) energy exchanges are the sense stimulators that enable us to form mental images of this world. These images create our sense of reality. This world can be termed the *Energy World* since energy-exchange to our senses is the *unique* feature that allows us to observe it.

SECTION II

SECTION III THE INTER-DEPENDENCE OF LAWS, PARTICLES, AND THE UNIVERSE

Figure 10.2. The Boot-strapped Universe. This diagram illustrates the inter-dependent relationship between particles, Natural laws and the Universe. All matter and laws depend on the properties of space (ether; or ZPE are other terms,) because space is the medium of quantum waves constituting matter. These quantum waves, which form the structure of the particles, provide continual communication between particles. The Universe is the sum of the quantum waves which form the particles in space. The Natural Laws are found in the behavior of the waves of the particles, exactly as surmised by Mach, a century ago. Thus, laws, particles, and the Universe are an inter-dependent trilogy where matter depends on matter.

The second view (interpretation) is the unseen quantum waves that form the structure of the fundamental particles: electrons, protons, and neutrons, and *space*. This *Quantum Wave World* is the hidden fountainhead which determines the real action in both worlds. These three particles make up the material objects of our energy-world. We cannot observe these waves directly with our senses although they fill the empty space around us. We only know of their existence from special instruments like gyroscopes, and from the quantized behavior of matter. For example, we are aware of quantum space when two particles change their quantized wave states (an energy exchange) in concert, and release a quanta of 'light'. For example, one particle in a star and the other in the retina of our eye that sees a hydrogen spectrum. This exchange called 'light' is quantized because it has a single frequency. The quantum world is the only real world because all matter is composed of quantum wave structures.

CONCLUSIONS. The eight attributes of the Universe conform with the wave structure of the electron. This structure settles the centuries old paradox of whether particles are waves or point-like bits of matter: They are waves. After some thought, it becomes clear that only a wave structure can explain the eight attributes. This structure is further verified because the natural laws originate from it. Knowledge of the origins of the laws opens a window on the physics, chemistry, biology, and technology of the universe around us.

THE UNIVERSE IS A SELF-CONTAINED ENSEMBLE. The most striking conclusion of the WSM is that the laws of physics only depend upon the two properties of *space* that in turn depend on the total matter in the Universe. Each particle communicates with all other matter so that the laws of Nature (physics) are properties of the entire matter ensemble.

ELEVEN

ASTRONOMY & COSMOLOGY

- I. An analysis of the Red Shift and the Big-Bang
- II. Calculating the Finite Universe
- III. Conservation Rules in a Finite Universe

*"To find diamonds you have to dig
somewhere everyone else isn't digging."*

– Fred Hoyle



In previous chapters we have found as Einstein surmised, that the electron is the most important particle of the Universe. This is because its wave structure extends throughout the Universe and every electron is inter-connected with every other electron or charged 'particle'. The IN and OUT waves of the charged 'particles' are the mechanisms of their inter-connection. The electron's immense importance is also seen from Principle II, derived from Mach's Principle, which makes it clear that matter and the Natural Laws on Earth could not exist without the presence of other matter of the Universe. In short, you and me, and the Universe are one integral whole.

Suddenly these inter-connections open a new window of application for the WSM – Astronomy and Cosmology. It now becomes possible to understand the behavior of cosmological events such as gravity, general relativity, and the red-shift that were formerly only perplexing puzzles arising out of the former discrete particle model of matter. Understanding these with the new vision of the WSM is the purpose of this chapter.

We discuss only a few puzzles below but there are dozens more that you the reader will probably think of as you read on. The authors join you and enjoy with you your future explorations in this fascinating arena!

SECTION I AN ANALYSIS OF THE RED SHIFT AND THE BIG-BANG

THE BIG-BANG. The red shift that led to the Big-Bang was discovered by Edwin Hubble 90 years ago. It is the simple and surprising observation that spectral lines in the light from different stars shift their wavelength towards longer wavelengths (toward infra-red) in proportion to the distance of the star from the Earth. He measured the fraction of wavelength shift and star's distance d and then defined a constant H ,

$$v = H d$$

Where v is the apparent velocity, of a star and d is its distance from us. The velocity is obtained using the assumption that v produces a Doppler wavelength shift – the *red shift*. Some theorists believe it is caused by an expansion of the space of the Universe. Hubble did not believe this notion of expansion stating that he felt that unknown factors were involved. The distances d and the red shifts are firm experimental facts for most stars, but no one knows if an actual expansion exists. Nevertheless, an expansion of the Universe after an initial "Big-Bang" beginning makes popular reading regardless of its fantasy fiction origin and lack of evidence. It has become a widespread concept! This Section seeks to find real evidence for the truth of the red shift.

The reciprocal of H is a time $T = 1/H$, which is often assumed to be the age of the universe. It is imagined that if time began at $T=0$ with a Big-Bang that this was the beginning and origin of all matter of the Universe. If light travels for a time T it will travel a distance $R=cT$, often called the 'Hubble distance'. This R also represents the largest distance from which we can receive information by light transmission if our cosmological age is T .



Below, we investigate Hubble's constant **H** and the origin of the red shift by using the concept of the Wave Structure of Matter (WSM). WSM replaces the ancient notion of matter as discrete 'particles'. The WSM has been very successful in explaining most puzzles of modern physics and it offers new insights. For this reason it is expected that the WSM can also clarify the meaning of Hubble's **H** and the true origin of the red shift. This will set aside the Big-Bang as a possible explanation, and shed light on the origin of the Universe.

The meaning of the red shift and Hubble's **H** have been mysterious controversies since Hubble's discovery. There is more to it than the speculative, Big-Bang notion that actually has very little evidence for it. Rather than accepting the Big-Bang notion, other calculations here suggest a close relationship between the Hubble constant **H** and fundamental properties of the cosmos. This is the main purpose of this section.

One surprising new relationship indicates that all matter: you and I, living things, and the Earth itself are interconnected with all other matter of the Universe. Matter and ourselves do not exist separately but are part of one whole Universe. Other calculations show connections between Hubble's constant **H** and properties of the electron. These are derived below.

PUZZLES OF THE BIG-BANG. Many books have been written describing these puzzles. A good reference is *The Big-Bang that never happened* by Eric Lerner (1992), a NY Times best seller. Lerner shows that the Big-Bang (BB) notion makes tremendous demands on credulity. To name just a few:

- 1) The BB assumes the laws of physics are unchanged throughout the violent process. Is this possible when initial matter was concentrated a billion, billion times more dense than today?
- 2) What happened before $T = 0$? Can time really just turn on and off?
- 3) It is well known that mathematics goes awry at points of infinity. How can one believe mathematics at $T=0$ when density is infinite?
- 4) There are no other cases of infinity occurring in Nature (physics).
- 5) Attempts were made to justify the BB by calculating the quantity of hydrogen and helium atoms in the universe formed from initial energy. The calculations were in error by factors of 100X or more. So these calculations were patched by assuming several more 'super-inflations.' No logic was provided for the patching; just fix-up.

THE MEANING OF THE HUBBLE DISTANCE IN AN INFINITE UNIVERSE.

Einstein and other philosophers of science argued convincingly that both time and distance in the Universe must be infinite (no Big-Bang) otherwise there would be *discontinuities* in the structure of space and time. And in fact, there is no evidence for discontinuous borders of any fundamental object in Nature. Thus the questions are raised: "What is the meaning of the Hubble Distance R ? Why does this special finite distance exist in an infinite Universe? We will try to answer these questions using knowledge of the Wave Structure of Matter (WSM).



THE WAVE STRUCTURE OF MATTER VERSUS DISCRETE PARTICLE MATTER. The puzzles of the red shift and the Big-Bang arise partly because of the assumption that matter is discrete material particles like grains of sand, as originally proposed by the Greek Democritus. (See chapter on History) These puzzles disappear if you discard the notion of discrete particles and replace it with the proposals of Clifford (1870) and Schrödinger (1937) that the Universe consists of wave structures in *space* and our observations of natural laws and the particles are the appearances of the waves. William Clifford was a famous mathematician and astronomer in Cambridge University who is remembered for *Clifford Algebras*. Erwin Schrödinger was a co-discover of quantum theory and is best known for the *Schrödinger Equation* used to describe wave functions of the hydrogen atom.

Those who believed in discrete particles followed the view of Niels Bohr's Copenhagen group that Schrödinger's wave functions were only the probability of finding the particle somewhere inside the wave functions. Both Einstein and Schrödinger disagreed with Bohr. Expressing his disagreement, Einstein made his famous remark, "God does not play with dice." Today, most of the physics community agrees with Bohr. Nevertheless as Tolstoy observed, "*Wrong does not cease to be wrong because the majority share in it.*"

REVIEW OF THE WAVE STRUCTURE OF MATTER.

The following is a short review of the Wave Structure of Matter (WSM) that is necessary to understand the Hubble H, the red shift and the Big-Bang. A more complete description of the WSM is in Chapter 2, 3, 12 and 13 as well as the two websites:

SpaceandMotion.com
QuantumMatter.com

At small dimensions, experimental data of the electron displays wave properties, for example in optical fibers and chips. Especially, energy exchanges appear to be between *wave-structured electrons* in a quantum space medium, rather than between discrete particles. Such structures must obey a 3D wave equation in 3D space. The solutions of the wave equation are found to be the origins of electrons, all the natural laws, and the whole of Nature, as proposed by Clifford and Schrödinger. All wave structure is based upon two principles:

PRINCIPLE I describes the wave medium using a Wave Equation. Its solutions are two spherical waves of the electron or positron. The wave-rules of electron-wave combinations and quantum spin determine the Atomic Table that underlies all molecular matter: metals, crystals, semi-conductors, and the molecules of life. These are the simple origins of natural laws. Below is a summary of the math in Chapter 2 and the math appendix:

Principle I is written: Quantum matter waves exist in space and are solutions of a scalar wave equation:

$$\nabla^2 \Phi - (1/c^2) \partial^2 \Phi / \partial t^2 = 0$$



Where Φ is a scalar amplitude, c is the velocity of light, and t is the time.

Its solutions in Figure 1.1 are a pair of spherical in/out waves:

$$\text{Outward wave} = \Phi_{\text{out}} = \Phi_0 \exp(i\omega t - ikr)$$

$$\text{Inward wave} = \Phi_{\text{in}} = \Phi_0 \exp(i\omega t + ikr)$$

There are only *two* combinations of these two waves. They have opposite spins that form the electron and positron:

$$\text{electron} = \Phi_{\text{in}} - \Phi_{\text{out}} \text{ with CW spin}$$

$$\text{positron} = \Phi_{\text{out}} - \Phi_{\text{in}} \text{ with CCW spin}$$

Where CW and CCW indicate two directions of spherical rotation. The variety of molecules in the universe is enormous, but the building bricks are just two. Thus Nature has built a binary universe.

MACH'S PRINCIPLE concerns our human frame of reference for observing motion of objects. He asserted (1883): *"Every local inertial frame is determined by the composite matter of the universe."* His deduction arose from two different methods of measuring rotation. First, without looking at the sky one can measure the centrifugal force on a rotating mass m and use the inertia law $F = ma = mv^2/r$ to find circumferential speed v and position, as in a gyroscope. The second method is to compare the object's angular position with the fixed (distant) stars. Surprisingly, both methods give the identical result. Thus the inertia law must depend on the fixed stars.

PRINCIPLE II - SPACE DENSITY PRINCIPLE. This principle is a quantitative version of Mach's Principle and determines the density of the quantum space medium: *waves from all particles in the universe combine their intensities to form the wave-medium density (space) at each point in space,*

$$\text{Space density} \propto mc^2 = hf \propto \sum_1^N [\Phi_n / r_n]^2 \quad (4)$$

That is, the frequency f or mass m of a particle depends on the sum of squares of all wave amplitudes Φ_n from the N particles inside the "Hubble universe". The number of particles in the Hubble universe is large $N \sim 10^{80}$ thus the space density is nearly constant everywhere and we observe a nearly constant speed of light. But close to large astronomical bodies like the Sun, their extra mass makes a tiny change of space density to produce a curvature of the paths of light or matter waves. This is the origin of the force of gravity and of Einstein's General Relativity.

Note that we have assumed that the entire Universe is contained in a sphere with the Hubble distance R as its radius. Without this assumption density becomes infinite and the WSM as well! We will discuss this later in connection with the red shift.



MINIMUM AMPLITUDE PRINCIPLE III (MAP). A third very useful principle can be obtained from Principle II [Haselhurst 2005].

The total amplitude of particle waves at every point always seeks a minimum.

$$\sum_i^n \Phi_i = \text{a minimum}$$

MAP is the disciplinarian of the universe. **MAP** is seen in situations like the leveling of water in a lake and the flow of heat that moves from a hot source to a cold sink; MAP is the origin of the *entropy principle*.

There are two immediate observations:

Space, described by these two principles, underlies all the natural laws of science.

When mass is accelerated, an energy exchange takes place between waves of the mass and the surrounding space medium. Thus the space medium, created by the mass of the Universe is observed as the inertial frame of $\mathbf{F}=\mathbf{ma}$ as Mach asserted.

THE MEANING OF HUBBLE'S CONSTANT IN COSMOLOGY

The WSM reveals a new meaning of the Hubble distance because R is involved in basic mathematical relationships (below) describing properties of matter and space. They suggest that R is a finite distance in an infinite Universe, related to our ability to see into the depths of space. If these relations are true, and it is highly improbable that they all occur by coincidence, a clear meaning of the red shift appears. The need for a bizarre explanation like the Big-Bang disappears.

EQUATION OF THE COSMOS. In order for an electron energy transfer to appear to be a 'particle' at a point, the electron waves must propagate non-linearly at the central region. This produces the *coupling* between two resonances that allows energy transfer. We observe this process and call it "charge." Thus the density of the waves of an electron, inside a radius r_e from the wave-center, must be equal or larger than the density of background waves from all the rest of the matter of the universe. The result of this assumption can be found by setting:

Electron wave density at r_e = wave density of the Universe.

Evaluating this equality yields

$$r_e^2 = R^2/3N$$

This is called the *Equation of the Cosmos*, a relation between the size r_e of the electron and the size R of the Hubble Universe. Astonishingly, it describes how all the N particles of the Hubble Universe create the "charge" region r_e of each electron. The largest dimension of the Universe determines the smallest!



Can this Equation be tested? Yes. Insert the best astronomical measurements, $R = 1.3 \times 10^{10}$ light-years and $N = 10^{80}$ particles, to obtain $re = 6 \times 10^{-15}$ meters. This should be near the classical radius, e^2/mc^2 , of an electron, which is 2.8×10^{-15} meters. This is a close match thus the equation is satisfied by astronomical measurements. The simplicity of this result is surprising only because we under estimate the simplicity of Nature. When we speculate, we are often led down the primrose path of complex theories and difficult mathematics. In this situation when calculating the size of the Universe only a finite R makes sense.

OLBER'S PARADOX. Olber pointed out that if the volume of space were infinite, the number of stars would be infinite, and we should see the entire sky with the light intensity of the surface of a star like the Sun. We do not see this, thus the *observable* universe must have a finite R . Is this because our depth of vision is limited in a real Universe that is infinite? This appears to be the case. Below we will see that the WSM results in a finite observable Universe and yet allows an infinite Universe to exist as thought by Einstein. But there is little we can know about the infinite Universe because it is unobservable.

THE IN-WAVE PARADOX. This is similar to Olber's paradox. If the number of particles (wave centers) were infinite in the Universe, their contributions to the in-wave of each individual wave center would be infinite. This would make the density of every wave-center (electron) infinite. Even worse, the density of space would also be infinite. Neither of these is observed thus the effective volume of contributing wave-centers must be finite. The conclusion is inescapable that our vision into distant space is limited.

ORIGIN OF THE RED SHIFT.

Having found that the Hubble Constant H , or Hubble distance $R = c/H$, determines the size of electrons and other relationships of the Universe, it is clear that the Hubble constant plays a more fundamental role than just an explanation of an apparent expansion of space. We will deduce below that red shift and R are a result of a fundamental property of space, specifically that the range of astronomical seeing is limited by the WSM. Thus the range of the in/out waves that inter-connect the Universe is finite.

SCATTERING OF QUANTUM IN-WAVES. The WSM provides an explanation of the Hubble distance R by showing how the range of the quantum in/ out-waves is limited. Consider a single wave-center WC (a particle). Its IN-waves are formed by a Huygens's combination of waves from other wave-centers in the Universe (See Wheeler and Feynman's *Response of the Universe*, 1945). However, all of the out-waves from the distant universe cannot reach that wave center if they are blocked, absorbed, or scattered by intervening centers. The reduction of wave intensity of the in-coming out-waves from the Universe can be calculated using the ordinary formula for exponential reduction of a source in an absorbing/scattering medium:



Choose a sphere in space with radius R around a given wave center. Space in this sphere is filled with particles (wave centers) whose density is n particles per cubic meter. Incoming waves are scattered, blocked or absorbed by each WC inside the sphere. Thus the initial wave intensities I_0 entering the sphere are reduced along the radial line r . The result is much like the reduction of light from the headlights of an oncoming car in a fog. At a certain distance, the headlights appear and brighten as they approach. If we assume that the range r of the WCs inside the sphere is given by the Equation of the Cosmos, the resulting in-wave intensity is exponentially reduced:

$$I = I_0 \exp^{-r/(4\pi R)}$$

Where R is the Hubble radius of the universe. Thus $4\pi R$ is analogous to the distance when the car lights appear. We deduce that the in-waves to a wave-center arise from only a nearest region whose radius is less than about $4\pi R$. Thus wave-communication is drastically reduced between very distance objects. This limitation on the size of R is the new fundamental meaning of the Hubble Universe; a finite observable Universe.

A FINITE SPHERICAL UNIVERSE WITHIN AN INFINITE SPACE.

When people first consider the Wave Structure of Matter there is a common mistake of thinking of just one wave-center, a spherical standing wave, as being alone in infinite space (which is clearly not how reality is, as there is obviously matter all around us). That thought leads to imagining incorrectly that the spherical standing wave structure extends to infinity.

However, the correct way of thinking (matches reality of what we experience) is that the Hubble space around us has lots (and lots!) of other matter in it. And the calculation above shows that although you may be in an infinite space (as a wave-center) there is only a finite amount of other matter that directly contributes to your in-waves. So we see that each wave-center 'particle' is really the center of its own universe. (You and me, are each the center of our own universe - what a nice thought). And this applies to any matter, wherever you are in an infinite space. So the fact that an electron has a finite mass, and the fact that the Universe has a finite observable range, are two sides of the same coin.

When matter is close to other matter, their universes (of in and out waves) overlap and you get matter interactions. For us on Earth, matter that is a 1,000 billion light years away is outside our finite spherical Universe and we can't interact with it — or see it. It does not contribute its OUT-waves directly to our IN-waves — it is hidden behind other matter.

So the WSM Cosmology explains how we each exist at the center of our own finite spherical Universe within an infinite space. I exist at the center of mine, you at the center of yours. But if it happens that our centers are close together, because we are both on the Earth, we share 99.9999% of a common universe - which is why we can interact with one another, write to each other on the internet.

CAUSE OF THE RED SHIFT.

SECTION I

And if you think about it, you realize that this must also cause a red-shift with distance, because distant matter shares less of a common universe, thus less wave interactions, thus less energy exchange (which we see as a red-shift with distance). Any smart mathematician can deduce this - just work out how the volume of two overlapping spheres changes as you move them apart — this should lead to red shift with distance - another meaningful deduction from the WSM.

MOST SCIENTISTS WILL DENY NEW TRUTHS. The red shift is bound up in controversy and beliefs have condensed around a few opinions. Only a few of the people who regard themselves as scientists recognize truth when they do not understand it. The typical scientist reacts as Churchill wrote: *"Most of us often encounter the truth but we usually pick ourselves up and pretend it did not happen."* Instead they choose to find reasons to deny the truth as was recognized by Maeterlinck: *"At every crossroad on the way that leads to the future, each progressive spirit is opposed by a thousand men appointed to guard the past."* (Count Maeterlinck, 1911 Nobel Prize Winner – Literature). Truth is no match for emotions.

A remarkable example is the current Standard Model of the Universe used by particle physicists. It models matter and the laws of nature on the assumption that discrete matter particles exist. It denies the obvious fact that matter and the laws are inter-connected throughout the universe as evidenced by Mach's Principle. This model contradicts the reality of laser gyros that guide most of the commercial aircraft today. It assumes that quantum space is a fiction in order to support the Bohr interpretation of Schrödinger's Quantum Equation who claimed that its solutions are statistical probabilities of finding particles. Schrödinger himself of course rejected this interpretation. That the Equation, mathematically, does not require such an interpretation is ignored. The unproven fantasy of the Big-Bang is a sacred part of the Model. One can wonder if the Standard Model is a new religion and the Big-Bang is the chalice on it is alter.

CONCLUSIONS FROM THIS SECTION:

1. The Hubble distance H is the maximum finite distance we are able to observe in an infinite Universe.
2. The Big-Bang never happened because instead the red shift is a consequence of the limited range of in/out waves in the observable universe.
3. Einstein was correct that the Universe is infinite in extent.
4. Schrödinger, DeBroglie, and Clifford were correct that all matter is wave structures in a space medium.
5. The theory of Neils Bohr and Max Born that discrete particles exist as probabilities within a Schrödinger wave function is wrong. Instead the wave functions themselves are the matter we observe. Discrete particles do not exist.



SECTION 11 CALCULATING THE FINITE UNIVERSE

Below we will see that the WSM and its astronomical partner the General Theory of Relativity (GTR) make it possible to find meaningful relationships between various dimensions of the Universe ranging from the size of the electron to the size of the Hubble Universe.

ENERGY EXCHANGE IS THE SOURCE OF INFORMATION. All astronomical measurements have one thing in common. Everything we measure in Nature requires an energy exchange that tells us something has happened. This is a requirement to find truth. Experience tells us that acquisition of knowledge of any kind occurs only with an *energy transfer*. Natural law describes energy exchanges. Storage of information, whether in a computer disk or in our brain, always requires an energy transfer. Energy is required to move a needle, to magnetize a tape, to stimulate a neuron. There are no exceptions. Thus finding the energy transfer mechanism between particles is part and parcel of understanding the electron and the natural laws. You cannot accept any statement about the measurement of a natural event unless you verify the energy exchange that allowed it. Skepticism is good for science. The WSM provides the mechanism of energy exchange.

EVERYTHING FROM NOTHING. Edward Tryon made a calculation (1973) that shows it is possible that the sum of matter and energy of the universe is zero. At first, this seems ridiculous as we view the large positive matter of all the stars, but his analysis yields another view. His argument was that the total amount of matter (a positive quantity) is exactly balanced by gravitational energy between the stars (a negative quantity). He deduces that this would be true if the matter density of the universe today is exactly a critical value, as follows:

The energy of gravitation of a particle of mass m , acted upon by the rest of the mass M_u of the universe, from a distance r , is

$$\text{Gravitational energy} = E_g = -m M_u G/r$$

If we set the mass of the universe equal to the mass contained within a sphere of Hubble radius, $R = c/H$ and density ρ , and choose density to be critical ($\rho = \rho_c = 3H^2/8\pi G$ from Einstein's General Relativity), and set the average distance to the mass to be half the Hubble distance, or $r = 1/2 c/H$, then we get,

$$M_u = 4/3 \pi R^3 \times 3H^2/8\pi G = c^3/2GH$$

And inserting these into the expression for the gravitational energy, we get

$$E_g = -mc^2$$

This is a bit amazing! We see that the gravitational energy of a mass particle is just equal to the negative of its mass energy as Tryon proposed. The reason gravitational energy becomes so large is because the Hubble universe is so large.



Think about what happens if all matter 'particles' are moved an infinite distance apart. Then, using the equation above, the gravitational force between them is zero and both gravitational energy and mass are zero. Where has the mass energy gone? It has gone to moving the matter apart, so that now the total energy is zero. This example suggests that the geometric meaning of infinity is a distance so large that one matter particle cannot affect another. We also have to conclude that the constant of gravity is determined by the mass of all the atoms existing in the observable Hubble universe.

GRAVITY AND THE MYSTERY OF DIRAC'S LARGE NUMBERS. Is there a relation between properties of the particles and the Universe? Nobel laureate Paul Dirac who developed much of the quantum theory of the electron was never satisfied with its mathematical origin. He hoped that there were more fundamental ways to derive the quantum properties of the electron whose behavior dominates the most satisfying applications of quantum mechanics. In particular he hoped to find a relation between the properties of the universe as a whole and the properties of the electron. His hopes were stimulated by Mach's Principle, which mysteriously seems to show that the inertia of each micro particle is created by the mass of the universe. Following this philosophical goal, Dirac was constantly searching for relationships between the universe and the basic particles.

DIRAC FOUND RELATIONSHIPS BETWEEN THE LAWS AND PARTICLES.

He realized that the concept of the universe and its laws are meaningless without particles to populate it. Laws would be meaningless, because the particles are the objects of the laws. Second, the actual concept of Universe is the sum of the matter in it. Therefore, he anticipated a relationship of the laws to the electron and proton, which make up 99% of the matter in the universe. This particle-universe relationship is manifest like Mach's Principle. Dirac must have been motivated by this concept, although he never expressed it. He searched for relations of the type of Mach's Principle and found two that are discussed below.

DIRAC'S LARGE-NUMBER RELATIONSHIPS (LNR). Nobel Laureate Paul Dirac discovered two puzzling numerical relationships in astronomical measurements. The first relationship is:

$$e^2/Gm_eM_p = cT/(e^2/mc^2) = 10^{40}$$

The term on the left above is not a mystery; it is just the ratio of the electric to gravitational forces between an electron and a proton. It has a measured value of 0.23×10^{40} which shows how very much larger the electric force is compared to gravity.

On the right side, Dirac speculated that $cT = R$ is the radius (size) of the universe; R is the reciprocal of Hubble's constant. The divisor is the classical radius (size) of the electron, e^2/mc^2 . Dirac's mystery was: "Why should the size ratio of the smallest and the biggest objects of the Universe also be the ratio of the gravity (smallest force) and electric (largest) force?" Dirac never found a reason for his ratios.



Many persons have tried to answer Dirac using the particle notion of matter but none have succeeded. However if you now examine the Equation of the Cosmos above, from the WSM, you find that Dirac's LNR ratio is directly expressed in it. The WSM solves Dirac's first mystery.

DIRAC'S SECOND LARGE-NUMBER MYSTERY. Dirac found by comparing data of astronomy, that approximately:

$$G \rho_m / H^2 \sim 1$$

Where ρ_m = density of matter in the Universe and G is the gravity constant.

Dirac asked: "*Why should these enormous numbers yield the unlikely value of one?*" This mysterious large number ratio has lain unsolved for the last seventy years. It is surprising the Dirac did not notice that his ratio confirms a result from Einstein's General Relativity, namely that the critical density d_c of a 'flat' universe is:

$$d_c = 3H^2/8\pi G$$

Where H is Hubble's constant. If this is rearranged it becomes Dirac's ratio:

$$G d_c / H^2 = 3/8\pi$$

where the approximate density d_c from astronomical measures is the value used by Dirac except for a small factor of $3/8\pi$. If you accept General Relativity, Dirac's puzzle is solved.

ORIGIN OF THE GRAVITY CONSTANT. The value of the gravity constant G for the flat universe of Einstein's Relativity as above, is related to the Hubble constant:

$$G = 3H^2/d_c 8\pi$$

However there is no accurate evidence that the Universe is 'flat' since the astronomical measurements of density d_c are very uncertain. But it is very **suggestive** that the value of G agrees with the remarkable conclusions from Tryon's calculation above (Everything from Nothing). Namely: 1) that the energy of the Universe could have begun at zero with all matter initially at an infinite distance. And 2) that the gravity constant is determined by all the mass of the Universe. We have seen in the Chapter 5 on the Origins of Laws that 2) is true, when using the WSM.

ORIGIN OF NEWTON'S LAW OF INERTIA, $F = ma$. Newton's important law is the fundamental beginning of modern physics. Newton originally saw inertia as an *action-at-a-distance* paradox because he expected that a distant discrete body was the recipient of the inertial energy transfer not knowing of the WSM. For the same reason, Mach's 1883 assertion was also first regarded as a paradox despite its obvious truth.

We have seen that the origin and mechanism of inertia is a property of *space*, the wave medium of the WSM. *Space* is a result of Principle II above that establishes the density of *space* proportional to the sum of all the



waves from all other observable matter – i.e. the Hubble universe. Einstein's General Relativity does the same thing on an astronomical scale. In short, Newton's Law implies that *Space* and an accelerated particle m , exchange energy as if space were a 'force field' on an accelerated m .

Let's calculate the resulting force: Visualize space as a potential field $\mathbf{M}$ that produces a force $\mathbf{F}$ on a mass m with an acceleration $\mathbf{a}$. This is comparable to the electric force $\mathbf{E}$ that produces a force on a charge e . Energy is transferred between the mass and the surrounding space because the accelerated waves change relative frequencies. The resulting force and energy transfer appears instantaneous in agreement with astronomical observations and space missions.

There are two masses involved: One is m and the other is the equivalent mass M_u of the Hubble universe. Since we know the radius of the Hubble universe, $R = c/H$ we can find its average mass knowing its density. A density is given by the General Theory of Relativity as the critical density d_c of a 'flat' universe,

$$\text{Critical density} = d_c = 3H^2/8\pi G$$

The vector mass field $\mathbf{M}$ acting on the accelerated mass m is

$$\mathbf{M} = \mathbf{a}mG/c^2r$$

Where r is the average distance to the sources of the local space. This is taken as half of the Hubble distance $r = (1/2)(c/H)$. The equivalent mass of the Hubble universe is:

$$M_u = \text{density} \times \text{volume} = d_c \times (4/3)\pi(c/h)^3$$

Then the force between the mass field $\mathbf{M}$ and the mass m is

$$\mathbf{F} = \text{Force} = \mathbf{M} \times M_u = \mathbf{a}mG/c^2r \times 3H^2/8\pi G \times (4/3)\pi(c/H)^3$$

Surprisingly all the numerical factors above cancel and we are left with Newton's law

$$\mathbf{F} = m\mathbf{a}$$

Summarizing, we have used Principle II (from Mach's principle) that the *space* medium is established by all masses of the universe, and that the local medium exchanges energy with any accelerated mass. As a result, we obtain Newton's Law, predict a flat universe, and establish a mechanism for 'action-at-a-distance'.



SECTION III CONSERVATION RULES IN A FINITE UNIVERSE

ARE THERE CONSERVATION RULES OF THE UNIVERSE? We would like to know if the conservation rules for matter here on Earth also apply to the entire universe. Remember that the Earth-bound rules apply to a definite amount of matter free of external forces, termed a closed system. In that closed system, energy, momentum, charge, etc. are always constant. Is this also true for the universe? Does it behave like a closed system? Since there is not yet much evidence opposing this idea physicists often make the assumption that the universe is also a conserved closed system. But this is not a certain conclusion.

THE ZERO SUM IDEA. We have found here on Earth that the values of some conserved quantities add up to total zero. For example, the total charge of ordinary objects like books, houses, etc. are zero; that is the objects are electrically neutral. This is because the +charge of each proton in a hydrogen atom is balanced by the -charge of the electron around it, and because the rule of pair production requires that a positron accompany each electron created. All charges sum to zero. Similarly, we ask, is there a zero sum rule for properties of the universe?

ZERO SUMS OF MOMENTUM AND CHARGE. To say with certainty that the total momentum and charge of the universe are zero is beyond our capabilities, but it is consistent with existing measurements of radiation, spectra, and positions of celestial objects. In localized regions, charge or momentum may become non-neutral, but we can always identify a balancing charge or momentum change of opposite sign, somewhere nearby, that maintains overall neutrality. So tentatively, it is possible to presume their sum is zero.

A ZERO SUM OF MATTER, TOO? As described above in Section II, Edward Tryon (1973) proposed that the sum of energy and matter is also zero in the universe. Let's push Tryon's idea further. Suppose the universe was very small and only a few kilograms of hydrogen existed in the universe. Now, the conservation of energy requires that the mass of the H atoms be very tiny to match the tiny value of gravity. We have to conclude that all the matter of the Universe could have begun to form in an empty Universe when its matter density was tiny and forces were also very small. This is almost pure speculation so please don't consider it without more evidence, especially until we have learned better what is the nature of *space* itself.

'TURTLES ALL THE WAY DOWN' MAY BE THE FINAL ANSWER. You have probably read the story of the Newtonian scientist who challenged the religious theory that the World was supported on the shoulders of Atlas: he asked,

"What is Atlas standing on?" The reply was: "On a turtle."

Then, "What is the turtle standing on?"

"Another turtle. There are turtles all the way down!"

The physicist sneered and thought he had won his point.



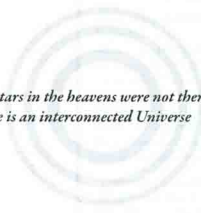
But as I understand the study of physics, it is probable that we may find "Turtles all the way down" as follows: At first we feel lucky because the Wave Structure of Matter neatly avoids the need to find an ultimate smallest particle as the building block of matter. This is because there are no building blocks made of discrete point particles. Space itself is the basic material of the WSM. A space resonance is the basic building block. Space neatly provides length, time and mass, the origin of laws and the 'particle zoo'. Wave-particle duality and other puzzles simply evaporate. But unfortunately, another enormous mystery pops up, "What is space?" Now suddenly space has to provide all the properties that we thought we had so cleverly explained. We are back to square one, smaller of course, but there are still "Turtles all the way down". There is never an end to the questions and understanding *space* is the next question.

Acknowledgement. The assistance of Geoff Haselhurst in writing this chapter is much appreciated.

TWELVE

MATHEMATICS FOR THE ELECTRON

- I. Solutions of the Wave Equation (Principle I).
- II. The Doppler Effect: Special Relativity and the De Broglie Wavelength.
- III. Inertia and the Coulomb Puzzle for the Electron.



*If the stars in the heavens were not there, we could not exist.
Nature is an interconnected Universe*

SECTION I SOLUTIONS OF THE WAVE EQUATION (PRINCIPLE I)

This chapter describes the WSM for mathematical persons; if you enjoy differential equations for breakfast you will read this. Publishers say that for every equation you write into a book, you will lose 10% of your readers. Thus forewarned we have placed the mathematics at the end where it will not disturb your digestion while you enjoy reading the book. Nevertheless, mathematics as the handmaiden of physics, is very useful; not only to gain a deeper understanding of physics but also to provide confidence. The two important topics of this chapter are: 1) The wave structure equations of the electron, and 2) The Doppler effect between two charged particles such as the electron and positron. The latter is the major origin of important natural laws.

The conservation of energy in the wave medium of space has only one scalar equation of wave motion:

$$\nabla^2 \Phi - (1/c^2) \partial^2 \Phi / \partial t^2 = 0 \quad (12.1)$$

where Φ = wave amplitude. The wave equation, (12.1), must be written in spherical coordinates because cosmological space has spherical symmetry. Uniform density of the medium (space) is assumed which yields a constant speed, c , of the waves (and light). There are only two solutions. They are:

$$\text{Outward wave} = \Phi_{\text{out}} = (1/r) \Phi_{\text{max}} \exp(i\omega t - ikr) \quad (12.2)$$

$$\text{Inward wave} = \Phi_{\text{in}} = (1/r) \Phi_{\text{max}} \exp(i\omega t + ikr) \quad (12.3)$$

where wave number $k = mc/h$, frequency $\omega = 2\pi f$, r = radius from the wave center, and energy $E = hf = mc^2$. These two waves form the complete wave-structure of charged particles including the electron, positron, proton, and anti-proton. Superposition of an inward wave and an outward wave produces a standing wave called a space resonance (SR), and can be done in two ways to form either an electron or a positron. At the center the inward wave undergoes a rotary phase-reversal, transforming it to the outward wave. This phase-reversal can also happen in two ways; two types of spherical rotation, CW or CCW. One is the electron, the other the positron, with opposite spins:

$$\text{An electron is: } \Phi_{\text{in}} - \Phi_{\text{out}} \text{ with CW spin} \quad (12.4)$$

$$\text{A positron is: } \Phi_{\text{out}} - \Phi_{\text{in}} \text{ with CCW spin} \quad (12.5)$$

where CW and CCW indicate two ways that the IN-waves spherically rotate to become OUT waves.



It is important to observe that a spherical in-wave is coming from all directions in spherical 3D space. The amplitudes arrive at a wave-center region (mostly near $r=0$), then in a rotary fashion, the amplitudes change their phase so as to form an out-wave moving in 3D spherical space.. This is not a 'stop-and-reverse' situation; If that happened momentum problems would arise. No. It is done by the only possible 3D mechanism called spherical rotation. The 3D geometry of the spherical rotation requires that the entire wave structure (in-wave plus out-wave) acquires a quantum angular momentum spin of value $\pm h/4\pi$.

It is philosophically sobering to realize that spherical rotation is a property of only 3D space; not 2D, 4D, or other space. Thus if spherical rotation did not exist, we humans, our Earth, all matter as know it (particles with spin and the consequent atomic table of elements) could not exist. Further, theoretical schemes of matter that postulate 5D, 10D, 11D space, etc. are patently invalid for it is impossible that they could include real matter with spin.

SWITCHING (INVERTING) PARTICLES BY EXCHANGING THEIR WAVES.

It has long been known experimentally that different particles follow similar patterns of behavior that depend on the charge, direction in time, and LH-RH handedness. These three are called the CPT inversions. An inversion means to switch to the other binary form; for example, in C inversion, a + particle is switched to a - anti-particle. An empirical rule is known that three successive CPT inversions always return to the beginning. The physical reason for this was never known using the material point-particle model of matter but using the WSM you can now see that the above equations (12.2,12.3) of the waves are the origin of CPT, as follows:

Make particle inversions by changing the + or - signs in the amplitude equations (12.2) and (12.3) of the two particles (12.4) and (12.5). To perform a Time inversion, change t to $-t$, which converts the positron into an electron. To perform a Parity inversion imagine that the waves are viewed in a mirror. Notice that a positron is the mirror image of the electron. To change a particle to an anti-particle (Charge inversion), switch the in-waves with the out-waves and change the direction of spin. Thus, you can see that successive C, P, and T inversions returns to the initial state which is a proof of the empirical-theoretical CPT rule, now seen to be a property of the wave structure.

NO TIME TRAVEL? These CPT relations are the physical basis of Feynman diagrams that describe the behavior of electrons and positrons in experimental particle labs. You can now understand Feynman's cryptic statement, "A positron is an electron traveling backward in time." Although this statement led to many sci-fi films about time travel, the fact is the positron does not go

backwards. Only its inward and outward waves are opposite to those of the electron, as you can see above. It is still a normal particle.

SECTION II THE DOPPLER EFFECT: SPECIAL RELATIVITY AND THE DEBROGLIE WAVELENGTH

A very important property of the in-out wave solutions is the Doppler effect between two space resonances (SR). Doppler leads to the origins of special relativity and the de Broglie wavelength, the basis of the Schrödinger Equation. This result is entirely a wave property and thus cannot be found using a discrete particle model of the electron.

Examine the Doppler Effect by writing the equation [12.4] of a SR, as seen by an observer with relative velocity $b = v/c$. The relative velocity causes the in-waves to be red shifted and the out-waves to be blue shifted according to the relativistic Doppler factors D and $1/D$ respectively,

$$D = g(1 - b), \quad 1/D = g(1 + b), \quad \text{and} \quad g = (1 - b^2)^{-1/2} = [1 - v^2/c^2]^{-1/2}$$

The Doppler effect is obtained by inserting the Doppler factors, D , $1/D$ and g above into Eqn [12.4] to get the Doppler shifted wave amplitudes received at either particle:

$$\Phi(\text{electron}) = A_{\max} \exp[i(ct + r)k/D] + A_{\max} \exp[i(ct - r)kD]$$

After multiplying this out and rearranging the terms, the amplitudes received by the moving observer are then,

$$\text{Received amplitude } \Phi = (1/r) [2\Phi_{\max} [\exp[ikg(ct+br)] \sin[kg(bct+r)]]] \quad (12.6)$$

The RH side of [12.6] contains an exponential oscillator modulated by a sine factor. By examining these two factors we will find the origins of QM (the de Broglie wavelength underlies QM) and the relativistic energy and momentum (the mass increase of special relativity). The received amplitude factors are:

In the exponential factor:

Wavelength = $h/mvg = \text{de Broglie wavelength with relativistic momentum.}$

Frequency = $kgc / 2\pi = gmc^2 / h = \text{mass frequency with relativistic energy.}$

And in the sine factor:

Wavelength = $h/mcg = \text{Compton wavelength with relativistic momentum.}$

Frequency = $b gmc^2/h = b \times (\text{mass frequency}) = \text{relativistic momentum frequency.}$

QM AND SPECIAL RELATIVITY ARE THE RESULT. You see that the Doppler factor g causes the correct de Broglie wavelength and relativistic mass to appear in the observed waves, as a function of the relative velocity. This corresponds exactly to experimental observation. This Doppler result removes



SECTION II

the puzzles and mystery of the old discrete particle model of matter where you are told that mass is a fixed property and then later you are told it is a changing property depending on motion v/c . But you are never told why. Now we see that mass, energy and frequency are the same quantity using different units: $E = mc^2 = hf$ because of the WSM.

It is important to note that the effect is symmetrical; it does not depend on whether the relative velocity is $+v$ or $-v$. This is exactly as observed. Importantly, examination of the algebra shows that this is due to the symmetrical presence of *both* the inward and outward waves. Thus the origin of both QM and relativity requires the existence of both in- and out-waves.

We see the space resonance displays all physical properties of an electron, viz: electric charge, QM, SRT, forces, annihilation, spin (more in the next chapter), conversion to a positron, and CPT relations between Charge, Parity, and Time; all of which were formerly only empirical or theoretical properties. The origin of these physical properties depends on the spherical wave structure of the electron and ultimately on the wave medium of space.

To a scientist familiar with wave optics, the truth of the wave structure of an electron seems irrefutable. This is the way waves behave. On the other hand, if one thinks only in terms of discrete particles it may be difficult to see the origins of QM and relativity.

SECTION III INERTIA AND THE COULOMB PUZZLE FOR THE ELECTRON

FORCE ON AN ACCELERATED MASS. This first calculation of inertial force, $F = ma$, involves the wave structure of matter in cosmological space, and space as the wave medium. It shows the cosmological origin of the inertia law. The calculation uses three concepts as follows:

- a) **The theory of general relativity is correct.**
- b) **The Hubble radius is a meaningful measure of the size of our observable universe.**
- c) **Mach's Principle is correct. This is one of the two basic assumptions of the Wave Structure of Matter.**

This calculation uses human scale versions of the physical laws that do not incorporate the quantum scale of energy exchange, so the result, like most of the force laws, is only valid in the human realm of observation. Why this calculation works is somewhat mysterious. Perhaps a clever mathematical reader will be able to analyze it further and provide an in-depth explanation. A second different way to calculate inertial force is given in the Astronomy Chapter 11, section II, Origin of $F=ma$.

We are going to make an analogy between the electric field and an inertial 'field'. The analogous electric field we use is caused by acceleration of a charge which experiment has shown to be equal to the rate of change of the magnetic vector potential, **A**. The inertial force is caused by a new (proposed here) analogous "mass-field potential".



THE ELECTRIC COMPARISON: For an electric field we already know:

$$\text{electric Force} = e' \times E \quad (\text{where } E = \text{electric field}) \quad (12.7)$$

Then we choose to assume an analogy that:

$$\text{mass Force} = m' \times M \quad (\text{where } M = \text{mass field}). \quad (12.8)$$

Since the E field depends on magnetic vector potential A ,

$$E \text{ field} = \partial A / \partial t = (e)(a) / (4\pi\epsilon_0 c^2 r), \quad (12.9)$$

the assumed analogous mass field is,

$$\text{mass field} = M = (m)(a) (G) / (c^2 r). \quad (12.10)$$

Where the electric field constant $4\pi\epsilon_0$ is replaced by the gravitational

constant, G . We are going to assume that the inertia of moving a mass m is caused by this mass field, M , created by all of the matter in the universe.

That is, when a mass is accelerated, it is the universe's mass field that opposes the change of velocity. Accordingly, let m' equal the mass of the universe and d_u equal to the mass density of universe. Then:

$$m' = (d_u)(\text{volume}) = d_u 4/3 \pi R^3 \quad (12.12)$$

Choose the mean distance R of m' equal to half the Hubble radius, $R = c/H$.

We have assumed that the observable universe has a meaningful measure of size, R , determined by the Hubble distance measurement. Then inertial force becomes:

$$\begin{aligned} \text{Force} &= (m')(M \text{ field}) = d_u 4/3 \pi (c/H)^3 (m a G) / [c^2 r] \\ &= \{(8\pi G d_u) / 3H^2\} m a \end{aligned} \quad (12.13)$$

where it is assumed that the density of the universe is 'flat' according to General Relativity. Actually, there are not enough measurements yet to know whether it is flat, more dense, or less dense so this is only a reasonable possible assumption. So, assuming a flat universe, $d_u = 3H^2/8\pi G$ is the critical density of a flat universe in General Relativity. Substitute d_u into the equation above, we find the factor in braces $\{ \dots \}$ becomes unity and the remainder is:

$$F = ma \quad (12.14)$$

Thus, we have obtained Newton's Law of inertia! Is this an amazing coincidence or is it correct that inertia is caused by a mass vector potential field due to all the mass in a Hubble universe? This is the heart of Mach's Principle (1895). But Ernst Mach offered no calculation like this to prove it. Instead, he made only a logical deduction after observing that the fixed stars provide an absolute reference frame for centrifugal acceleration that agrees with experiment. This book is the first calculation.

THE SECOND PRINCIPLE OF THE WAVE STRUCTURE OF MATTER (WSM)

also uses Mach's Principle in a mathematical form. The correctness of this WSM assumption is well verified by its agreement with the empirical observations of the natural laws and Mach's Principle. Thus the WSM, and this derivation of $\mathbf{F} = m\mathbf{a}$ support each other. Therefore, we are tempted to make the following conclusions:

The density of the universe is flat.

General Relativity is correct. (It already agrees with the WSM.)

Since the gravitational constant G is used, gravitational mass = inertial mass.

The Hubble radius is a measure of the observable universe.

AN OLD PUZZLE — DIRAC AND THE POINT ELECTRON. Despite the engineering utility of Coulomb's point force equation, it has a history of severe theoretical problems mostly concerned with the infinite force, and infinite mass and energy predicted when radial distance to an electron becomes zero. The infinity problems are result of the point particle assumption. These problems disappear completely in the WSM because there are no point substances, only waves in space that appear point-like from a large scale view. The history of the infinity problems illustrates the importance of the WSM.

MATHEMATICAL HISTORY. In the 1930's QED mathematical theorists were wrestling with the structural problem of an electron. Using Maxwell's Equations for electromagnetic waves from the accelerated electron they worked out an expression for the forces as follows:

$$\text{Force} = k_1 [e^2/(c^2R)] \mathbf{a} - 2/3 [da/dt] + k_2 \times R e^2/c^4 [d^2\mathbf{a}/dt^2] + \dots \quad (12.15)$$

where $\mathbf{a}$ is acceleration, da/dt is the rate of change of acceleration, $d^2\mathbf{a}/dt^2$ is rate of rate of change of acceleration, R is the radius of the electron sphere, and k_1 and k_2 are constants. Note the minus sign before the second term.

Since the first term alone is like Newton's law $\mathbf{F} = m\mathbf{a}$, the coefficient of $\mathbf{a}$ was called the "electromagnetic mass". Obviously, if R in the denominator becomes zero, the electromagnetic mass becomes infinite. Since infinite mass and forces are never seen, R could not be zero. But if the electron was an elementary particle, R had to be zero to avoid explaining what the sphere was made of. Further, relativity demands $R = 0$ to avoid communication problems between parts of the sphere. These were serious dilemmas.

DIRAC'S WAVE PROPOSALS. Nobody wanted the first term and its troubles. The third and later terms didn't matter because the $1/c^4$ factor makes them too small to be observed. The second term, with $[da/dt]$, corresponded to the energy of radiation from an accelerated charge, an observed fact, so a lot of ideas were tried to retain it. All of the ideas led to conflicts with observations, until Paul Dirac said, "look, we found the force equation by using an out-going electromagnetic wave. Now if we assume a symmetrical in-coming wave, the sign of the $[da/dt]$ term is + instead of -. Therefore we can make a

new rule: 'An electron acts upon itself according to one-half of the difference of the outgoing and incoming waves that it produces'. This will cancel other terms and leave the one we want." No theoretical reason was found for this arbitrary procedure or to justify the in-coming electromagnetic wave. It was used simply because it worked! Wheeler and Feynman used this procedure in a famous article in the *Review of Modern Physics* (1945). But today we see it as a harbinger of the Wave Structure of Matter.

Dirac's scheme worked well for electromagnetic theory; the electromagnetic mass became zero and the radiation energy was right. But later when electromagnetism and quantum theory were joined in quantum electrodynamics (QED), the infinite mass problem reappeared because the point electron was retained. Once again, an arbitrary procedure was invoked. This was to cutoff the electron's field at a chosen small distance from the center to get the result they needed. In technical jargon, the procedure was called "renormalization". Both Feynman and Dirac objected to this arbitrary procedure. The WSM now shows their objection was right because: a) that chosen distance corresponds to the size of the wave center, and b) a discrete point particle does not exist.

Although we know now that the electron is not a spherical ball or a point particle, many of the ideas from this period 50 years ago are still alive. Which ideas are still valid and should be retained? Which were wrong and should be corrected? Science has no automatic means of self-correction. Only new scientists like you the reader with new ideas using the WSM can do this.

THE MATHEMATICS OF THE ELECTRON SPIN is given in the next Chapter. Spin is an interesting and important result of the WSM because like gravity it is entirely a wave property of matter. It cannot be understood in any other way.

THIRTEEN

MATHEMATICS OF ELECTRON SPIN

- I. What is Physical Spin?
- II. Dirac's Theory of Electron Spin.
- III. The Group Mathematics of Spherical Rotation.
- IV. The Magical CPT Operations and Spin.

"A Positron is an Electron traveling backwards in time."

– Richard Feynman



Dirac and others (see Eisele, 1960) developed a theory for the spin of the electron, which successfully predicted the positron (Anderson, 1922) and correctly provided the experimental value of the spin as $\hbar/4\pi$. Spin is widely accepted as a quantum mechanical phenomenon, but a physical description that provides an origin of spin has never been proposed. In other words, before this book, no one knew how or why spin happens; it was a mystery of quantum. Presenting a physical origin of spin, that agrees with quantum theory, the Dirac Equation, and the electron wave-structure of the Space Resonance theory, is the purpose of this Section.

Dirac calculated spin of a particle in units of angular momentum, however the mechanism is not like the rotary angular momentum of the Earth or a wheel, because we are dealing with quantum phenomenon; something is different. The value of spin is fixed – quantized – and independent of particle mass or angular velocity. Spin is found to be a property of 3D space and related to other properties of the electron's quantum wave structure. These spin-related properties are called charge inversion, mirror or parity inversion, and time inversion. They are operations on the wave functions of a particle, like flipping a switch, to change between two states, such as + and – or up and down. They are represented by the symbols C, P, and T. The special thing about them is that three successive operations on a particle are found to change the particle back to the beginning. This is written

$$\mathbf{C} \times \mathbf{P} \times \mathbf{T} = \text{invariant} \quad (13.1)$$

These operations are very simple and interesting so more will be written about them below. especially since no one knew why it happens that way before the WSM.

As discussed throughout this book, the electron is comprised of two spherical scalar waves, one inward and one outward. A phase shift of the inward wave occurs in the wave-center region near where $r=0$, and spin appears as a required rotation of the inward wave in order to become the outward wave. This requirement is a property of 3D space termed spherical rotation. To transform the inward wave to an outward wave and obtain the out-wave with proper phase relations requires phase shifts of the in-wave at the center. These phase shifts produce a spin value of $\hbar/4\pi$ in the entire wave structure as seen below. Because spin is the result of required wave phase shifts, a property of 3D space, spin has the same value for all charged particles independent of other particle properties.

Before the WSM, that fact that spin in say a heavy proton, is the same as in a small mass electron has been a mystery. If one uses a discrete particle model (as in the current Standard Model) conventional physicists calculate that a heavy proton should have a much larger angular momentum (spin) than a light electron. They imagine spinning particles like toy tops – the mistaken result of the discrete particle model. Now the WSM shows that the

SECTION I WHAT IS PHYSICAL SPIN?

origin of spin is a property of the 3D space medium. There is no mystery; all particles are in the same quantum-wave space and all have the same spin.

ROTATION IN SPACE HAS REQUIREMENTS: Any mechanism that rotates the in-wave phase (creating the quantum spin) must not destroy the continuity of the space. The curvilinear coordinates of the space near the particle must participate in the motion of the particle. Fortunately, 3D space has a unique way to do this termed spherical rotation. According to the group theory mathematics of 3D space, continuity is described by stating that the allowed motions must be represented by the SU(2) group algebra, which concerns simply connected geometries.

Spherical rotation is an astonishing property of 3D space. It permits an object structured of space to rotate about any axis without rupturing or twisting-up the coordinates of space. Space is flexed but after two turns, space regains its original configuration. This property allows the electron to retain spherical symmetry while imparting a quantized "spin" along any arbitrary axis. The inward wave converges to the center, undergoes phase shifts to become the outward wave. The in-waves and out-waves continuously go through the phase shift process; the spin is a property of the entire wave structure that exists in the 3D space medium.

The required phase shift is a 720° rotation that changes inward wave amplitudes to become those of the outward wave. There are only two possible directions of rotation, CW or CCW. One direction produces an electron with spin of $\hbar/4\pi$, and the other is the positron with spin of $-\hbar/4\pi$.

SECTION II DIRAC'S THEORY OF ELECTRON SPIN

The physical nature and cause of electron spin has been sought for 75 years ever since Nobel laureate Paul Dirac made a calculation of spin in 1926. His theoretical work predicted the positron, found five years later by C. D. Anderson. Only recently has the physical origin of spin seen to be a simple result of the wave structure of matter.

Dirac sought to find a relation between quantum theory and the conservation of energy in special relativity given by,

$$E^2 = p^2 c^2 + m_0^2 c^4 \quad (13.2)$$

He speculated that this energy equation might be converted to a quantum equation in the usual way, in which energy E and momentum p are replaced by differential calculus operators,

$$E = (\hbar/i)(\partial/\partial t) \quad \text{and} \quad p_x = \hbar(\partial/\partial x) \dots \text{etc.} \quad (13.3)$$

He hoped to find the quantum differential wave equation of the particle. Unfortunately, Eqn (13.2) uses squared terms and Eqn (13.3) cannot. Dirac cleverly decided to use the terms of Eqn. (13.2) without squares, by writing a matrix equation,

$$iE = \sum_i \alpha_i p_i c + \beta m_0 c^2 \quad (13.4)$$



Where p is the electron's momentum and $m_0 c^2$ is its energy. Dirac proposed that if I , the identity operator, and α and β were 4-vector matrices then Eqn. (13.4) would work. He obtained the famous Dirac Equation by combining Eqns. (13.3) and (13.4) to get,

$$I(i\hbar)\partial\Psi/\partial t = (c\hbar/i)\{\alpha_x \partial\Psi/\partial x + \alpha_y \partial\Psi/\partial y + \alpha_z \partial\Psi/\partial z + \beta m_0 c^2 \Psi\} \quad (13.5)$$

In general, Ψ is a 4-vector: $\Psi = [\Psi_1, \Psi_2, \Psi_3, \Psi_4]$. For the electron, this reduces to: $\Psi = [0, 1, \Psi_3(E, p), \Psi_4(E, p)]$ a vector with only two variables in it. Dirac then realized that for an electron only two wave functions, Ψ_3 and Ψ_4 , were needed since the other two terms are constants. Solving for the values of these two wave functions, he predicted an electron and a positron with energy and spin,

$$E = \pm mc^2 \text{ and spin} = \pm \hbar/4\pi \quad (13.6)$$

The positron was discovered five years later by Anderson (1931) and led to Dirac's Nobel prize.

Dirac simplified the matrix algebra by introducing 2-vectors (number pairs), which he termed spinors ($= \Phi$) that replace the 4-vectors. The spin 2-matrices ($= \sigma$), which operate on the 2-vectors, were defined as follows,

$$\sigma_x = \begin{vmatrix} 0 & i \\ i & 0 \end{vmatrix} \quad \sigma_y = \begin{vmatrix} 0 & -1 \\ 1 & 0 \end{vmatrix} \quad \sigma_z = \begin{vmatrix} i & 0 \\ 0 & -i \end{vmatrix} \quad \sigma_i = \begin{vmatrix} 1 & 0 \\ 0 & 1 \end{vmatrix} \quad (13.7)$$

Thus Dirac had created a two-number algebra to describe particles instead of our common single number algebra. This spinor algebra, while eminently successful, was entirely theoretical and gave no hint of the physical structure of the electron.

THE ORIGIN OF THE ELECTRON'S SPIN. Spin is an example of the depth and universality of the Wave Structure of Matter. It is now seen below that the inward-outward quantum waves are the physical structures that correspond to the Dirac spinors. The physical spinors (2-vectors) of the electron or any charged particle, are as follows,

$$\begin{aligned} \Phi \text{ spinors are: } \Phi_{in} &= (1/r) \Phi_0 \exp(i\omega t + ikr) \\ \Phi_{out} &= (1/r) \Phi_0 \exp(i\omega t - ikr) \end{aligned} \quad (13.8)$$

where $\omega = 2\pi f$ and $k = 2\pi/L =$ wave number. The discovery that spin (a real measurable momentum) is a result of rotation of the spherical quantum waves also shows that quantum waves are indeed real. A readable simple description of the algebra of the Dirac Equation is given in Eisele (1960). Battey-Pratt et al (1986) show spin in more detail.



SECTION III

THE GROUP MATHEMATICS OF SPHERICAL ROTATION

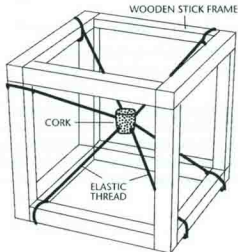
GEOMETRIC REQUIREMENTS OF ELECTRON SPIN. Electrons cannot spin separately from the space of which they are structured and connected. If they spin freely as discrete particles, the connected space would twist itself up; that is, the coordinate lines of space would stretch and wrap around one another. The structure of space would be torn or ripped; or, one part of space must slide past another section of space. This concept is illogical and meaningless. This is why spin is purely a quantum wave property of matter.

If you accept the reasonable philosophical view that discontinuities or "tearing" of space is unacceptable, then you have to postulate, in the jargon of mathematical groups, that the groups describing particle motion are simply connected and compact. In this case the motion in the space-continuum will be cyclic and the configuration of space can repeatedly return to an initial state. This motion is termed Spherical rotation, which is a unique mathematical property of 3D space; that is, a portion of space rotates and returns identically to an earlier state after exactly two turns. This unusual motion was described in *Scientific American* by Rebbi (1979) and in the book *Gravitation* by Misner, et al (1973) though they did not know at that time, its connection with spin. Its recognition as the basis of spin is a result of the WSM shown below.

GROUP THEORY OF SPIN. What are the geometric requirements on the spin of a particle wave, which does not destroy the continuity of the space? The curvilinear coordinates of the space near the particle wave-center must participate in the motion of the particle waves. That a compact simply-connected group represents the allowed motions satisfies this requirement according to the group theory of 3D space. The most elementary such group for the motion of a particle wave-center with spherical symmetry is named $SU(2)$. This group provides all the necessary properties of spin for charged particles, such as the electron.

UNDERSTANDING SPHERICAL ROTATION. A ball held by threads attached to a frame as in Figure 13.1, can model this seldom-studied motion. The threads represent the coordinates of the space and the rotating ball represents a property of the space at the center of a charged particle composed of con-

Figure 13.1.
A Model of Spherical Rotation. This apparatus is easily made out of a few sticks, a cork and six rubber bands. The cork can be rotated (taking care not to knot up the rubber bands) continuously without entangling the rubber bands! The cork and the bands will return to their initial configuration every two turns. This demonstrates a little known variety of rotation. It has application to particle theory because the spherical rotation does not destroy continuity of space.



verging and diverging quantum waves. The ball can be turned about any given axis starting from any initial position. If the ball is rotated indefinitely it will be found that after every two rotations the system returns to its original configuration.

INVERSION OF SPIN AXIS. In the traditional analysis of ordinary rotating objects, it is usual to assume that inverting the axis of spin is identical to reversing the spin. However, if the object is an electron, whose waves are connected to space as part of the space around it, this ceases to be true. A careful distinction must be made between the reversal and the inversion of particle spin. This distinction provides insight to one of the most fundamental properties of particles.

To *reverse* the spin axis, reverse time by changing t to $-t$ or reverse the angular velocity, w to $-w$. Either is equivalent to exchanging the outgoing spherical wave of an electron with the incoming wave. Then the spinor changes as follows:

$$\psi = \begin{vmatrix} e^{iwt} \\ 0 \end{vmatrix} \rightarrow \begin{vmatrix} e^{-iwt} \\ 0 \end{vmatrix}$$

To invert the spin axis of the structure of the particle, it is necessary to turn the structure about one of the two axes perpendicular to the z spin axis, for example the y -axis. Then the inverted spin state is produced by using the inversion matrix operator, so

$$\psi = \begin{vmatrix} 0 & -1 \\ 1 & 0 \end{vmatrix} \begin{vmatrix} e^{iwt} \\ 0 \end{vmatrix} \longrightarrow \begin{vmatrix} 0 \\ e^{-iwt} \end{vmatrix}$$

The *results* are not the same, so inversion and reversal are not the same. The difference between these two operations is characteristic of the quantum nature of the electron particle structure. They are different from our human-sized view of rotating objects.

Each configuration of the electron's wave-center (like a spherically rotating ball) can be represented by a point on a Euclidean 4-D hypersphere that is also the space of the $SU(2)$ mathematics group. Any operator that will transform one vector into another position can represent a spherical rotation. It is usual to assign the hypersphere a unit radius. Then the rotations of the ball can be described by the mathematics of the $SU(2)$ group. It is also convenient to place the center of the unit hypersphere at the origin and let the vector $(1,0,0,0)$ represent an initial configuration of the ball or electron. Any other configuration is often chosen with the symbols $(\alpha, \beta, \gamma, \delta)$. Then $\alpha^2 + \beta^2 + \gamma^2 + \delta^2 = 1$.

A common representation for the hypersphere vectors is the quaternion notation,

$$\Phi = \alpha + i\beta + j\gamma + k\delta$$



Batley-Pratt and Racey (1986) showed that the 4x4 quaternion operator is equivalent to a 2x2 operator,

$$\Phi = \begin{matrix} \alpha + i\delta & -\gamma + i\beta \\ \gamma + i\beta & \alpha - i\delta \end{matrix}$$

Where the matrix elements are now complex numbers that are combinations of 1, i, or 0. You can see that the determinant of this is also: $\alpha^2 + \beta^2 + \gamma^2 + \delta^2 = 1$, as above. The spinor (operand) form of Φ is,

$$\phi = \begin{matrix} \alpha + i\delta \\ \gamma + i\beta \end{matrix}$$

This is the notation of the Spinors invented by Dirac to represent the electron configuration, as shown in Table 13.1. They also represent rotations in the spherical mode that are members of the closed uni-modular SU (2) group.

Table 13.1: Properties of Spherical Rotation for an electron in the SU(2) Representation

Operation in SU(2) [Dirac symbol]	SU(2) Operator	Initial SU(2) Spinor	Final SU(2) Spinor	Equivalent Quaternion Operator
Leaves space as it is. [σ_0]	$\begin{matrix} 1 & 0 \\ 0 & 1 \end{matrix}$	$\begin{matrix} 1 \\ 0 \end{matrix}$	$\begin{matrix} 1 \\ 0 \end{matrix}$	1
Rotates space 180° about the x-axis. [σ_x]	$\begin{matrix} 0 & i \\ i & 0 \end{matrix}$	$\begin{matrix} 1 \\ 0 \end{matrix}$	$\begin{matrix} 0 \\ i \end{matrix}$	i
Rotates space 180° about the y-axis. [σ_y]	$\begin{matrix} 0 & -1 \\ 1 & 0 \end{matrix}$	$\begin{matrix} 1 \\ 0 \end{matrix}$	$\begin{matrix} 0 \\ -1 \end{matrix}$	j
Rotates space 180° about the z-axis. [σ_z]	$\begin{matrix} i & 0 \\ 0 & -i \end{matrix}$	$\begin{matrix} 1 \\ 0 \end{matrix}$	$\begin{matrix} i \\ 0 \end{matrix}$	k

For example, the spherical quantum waves in space are rotated 180° about the z-axis by the operator σ_z . If there is continuous rotation of the quantum wave in space with angular velocity w, the spinor ϕ is represented by the pair,

$$\phi = \begin{matrix} e^{w\tau} \\ 0 \end{matrix}$$

HOW SPIN ARISES FROM THE WAVE STRUCTURE OF THE ELECTRON.

As previously described in this book, the inward spherical quantum wave of the space-resonance is transformed into an outward spherical wave when it arrives at the wave-center. The only way that Nature allows this to happen in the geometry of 3D space is by a spherical rotation, or phase shift of the spherical in-wave, using the SU(2) group math above. The amount of phase shift required by the geometry of 3D space is two turns per wavelength, which results in a continuous spin of $h/4\pi$. This result is easy to calculate. Try it! This geometric mechanism of phase shift in an electron has an analogy in the required phase shift of light when it reflects at a mirror; it must shift an angle π so that the impinging wave is in phase with the reflected wave.

The required phase shift of the inward wave can happen in either of two rotary directions denoted 'CW' or 'CCW'. Thus there are two possible ways to shift the inward waves. One way of rotation produces an electron while the other way is a positron. The in/out wave pair of the electron is the mirror image of the positron pair. The resulting added angular momentum due to phase shift is either $h/4\pi$ or $-h/4\pi$. This is the origin of quantum spin.

SECTION IV THE MAGICAL CPT OPERATIONS AND SPIN

What did Feynman mean when he said: "*A Positron is an Electron traveling backward in time*"? As a mathematician he was speaking of the way you deal with electrons and positrons. Mathematically: To change the direction of time, you replace a 't' with a '-t': termed the T operation. This also appears to change the electron to a positron because it changes all the wave directions from IN to OUT and vice-versa. This is one of three operations on electrons called CPT operations described below.

CPT OPERATIONS. CPT means three instructions as follows: Using a particle of interest, perform the C operation on its structure, then the P operation, and then the T operation. Classical theorists knew that after all three operations the particle ends up un-changed, but before the WSM they didn't know why. To understand what CPT is all about, we must use the equations of an electron and a positron. They are Eqns. [12.2 and 12.3] in Chapter 12, solutions of Principle I – the wave equation. They are the only two possible spherical wave solutions:

$$\text{Outward wave} = \Phi_{\text{out}} = (1/r) \Phi_{\text{max}} \exp(i\omega t - ikr) \quad (12.2)$$

$$\text{Inward wave} = \Phi_{\text{in}} = (1/r) \Phi_{\text{max}} \exp(i\omega t + ikr) \quad (12.3)$$

Where Φ_{max} is a scalar wave amplitude, frequency $\omega = 2\pi mc^2/h$, $k =$ wave number. The physical dimension r is the radius of the spherical waves, from a wave center. The wave centers are the apparent location of the 'particles'. The waves are continually diverging and converging as drawn in figure 2.1. The wave pair forms a resonance in space with a wave-center that we observe as the 'particle' location.

THOUGHTS FOR THE READER: By the way, have you noticed yet that Nature makes two of everything? Is Nature a binary computer? Is Nature a synonym for 3D space?

WAVES OF THE ELECTRON-POSITRON. These two waves can be combined in only two ways to form the electron-positron. These are combinations of the in- and out- spherical waves:

$$\text{Electron} = \Phi_{\text{in}} - \Phi_{\text{out}} \text{ with CW spin} \quad (12.4)$$

$$\text{Positron} = \Phi_{\text{out}} - \Phi_{\text{in}} \text{ with CCW spin} \quad (12.5)$$

The in-waves reverse their direction at the center in one of two ways to become out-waves. This reversal is expressed mathematically by CW and CCW that are rotation (spin) operators on the waves. See the spin operators above. You can easily show that these two equations contain the CPT properties.

SPIN-AXIS OPERATIONS. Using the exponential wave solutions for the electron shown above, Eqns 12.2 and 12.3, you can reverse the spin axis, by reversing time ($t \rightarrow -t$) or by reversing the angular velocity ($w \rightarrow -w$). Both are equivalent to switching the outgoing spherical wave of an electron with the incoming wave. You may quickly check the particles with Eqns. [12.4 and 12.5] above. Another change is inverting the spin state; produced by the inversion matrix operating on the spinor. But this does not change the direction of the in/out waves.

The CPT operations are very simple. To perform a Time inversion, change t to $-t$, which converts the positron into an electron. To perform a mirror inversion (Parity), imagine that the waves are viewed in a mirror; a positron is a mirror image of the electron. To change a particle to an anti-particle (Charge inversion), switch the in-waves and the out-waves, and the spin. The successive **C**, **P**, and **T** inversions return an electron to its initial state proving that the CPT rule is a property of the wave structure.

PROTONS ARE DIFFERENT THAN POSITRONS. Consider why a proton is distinct from a positron. Both of them have identical charge waves, i.e. identical in-waves and out-waves, but the difference is at the wave center, as follows:

The positron in-wave arrives at the center, undergoes spherical rotation to change phase at the center, say CW (a rotary direction of an object) and leaves as an out-wave. But the proton is different because at the center the waves are part of a more massive resonance at a higher frequency, $f = Mc^2/h$ because the space is very dense at the center. Because of this dense central space the proton wave-center is not a mirror image of the electron's wave center; so the proton cannot annihilate with an electron. Nor can a positron annihilate with an anti-proton.

COMPARE THE ELECTRON AND THE POSITRON: One has CW phase shift at the center, the other has CCW shift. They are like the left hand and the right hand. One is the mirror image of the other. The amplitudes are exactly opposite so they can annihilate each other if super-imposed!

You can prove this: Go to the two equations [12.4 and 12.5] that are the in/out waves of the electron or positron. Choose the combination that forms an electron. Then perform a mirror image change (This is termed **P**, the parity operation) by switching $+$ and $-$ signs. This turns the electron into the positron. You can make the positron turn into an electron in the opposite way!

To further convince yourself, perform the **C** charge operation on the equations. (Switch the in-waves and the out-waves, and the spin). Lo! *The electron becomes a positron going backward in time!* This is the proof of what



Feynman said, but he only knew it from experimental observation not as a wave structure, that you the reader, now understand. You now know more than Feynman did! The electron does not really go backward in time (only in Hollywood) because by switching the $+t$ and $-t$ terms you only exchanged the in- out-waves that make the electron become a positron.

Feynman often used the math of in-waves and out-waves but he never gave up the concept of the discrete point particle. His colleague at Caltech, Carver Meade, admired him immensely but wrote (2000) in his book, on the particle concept, "*That was Feynman's biggest mistake.*"

CONCLUSIONS FROM SPIN. Following the previous chapters of this book, the origin of spin completes the description of the electron. All properties of the electron can now be derived from the space-resonance structure (WSM) that match the experimental observations of the electron that are contained in the half-dozen empirical natural laws.

Spin and Spherical rotation can occur only in 3D space, not 4D, 5D, etc. This is a geometric fact. Accordingly we must conclude that matter as we know it, indeed the whole Universe, depends on the existence of this 3D geometric property. If 3D spherical rotation and spin did not exist we could not exist! We barely understand Nature and its raw material space but we do know that Nature chooses binary objects and the properties of space are the origin of matter. The laws of nature are attributes of the underlying quantum space that is the wave medium. Thus the binary electron properties depend on the structure of space, not on the type of particle. This is why spin and charge have only one pair of $\pm$ values for all particles.



Knowing the true structure of matter allows calculation of many applications of material sciences that were poorly known before. Most applications involve understanding the behavior of matter at very *small dimensions* where the particulate approximation fails and the WSM is necessary to understand what is happening when different substances interact chemically, electrically, or biologically. Some occur in the computer field such as the development of semiconductor devices. Biological interactions, digestion, nutrition, and medicine, are very important in human health and can now be studied on a calculated basis. Chemical interactions are involved in the development of energy storage devices such as batteries, and in metallic alloys where the common R&D practice is trial and error. The WSM may improve this practice because knowing the true atomic structure often allows prediction of useful properties or to develop materials filling a specified need. The important feature of the WSM is that it is now possible to calculate and understand the binding between different atoms and molecules, due to resonant joining of wave structures between them. Formerly, this could not be done using discrete particle ideas and approximations. Some opportunities are discussed below:

OPPORTUNITIES.

The simplicity of the WSM provides easy access to the behavior of materials whose properties depend on their structure at the atomic level. This was not possible using the discrete particle model of matter because many materials presented property enigmas that were not understood. Using the WSM permits easy research of the material wave structure that joins atoms within the material and with external material. This knowledge and ability to calculate it can produce rewarding results. Probable cases are below:

GRAPHENE. This is a newly discovered form of graphite that exhibits unusual behavior not currently explainable using the discrete particle approximation. It occurs in flat sheets of carbon atoms, and in rolled-up sheets termed '*nanotubes*'. These sheets and tubes have extremely low electrical resistance and are being considered (2006) for use in microcircuits.

The current graphene enigma using the discrete particle model is described as: "*Graphene contains quasiparticles. They are of a type known as massive chiral fermions. Chirality refers to 'handedness', in that the left hand is the chiral opposite of the right hand. Unfortunately, discrete particle physics predicts that any particle that has chirality cannot have mass, so a massive chiral fermion is a contradiction in terms.*"

Graphene can be an opportunity for wave-matter theory to explain. It can be experimented on easily at room temperature, so predictions might be testable.

MAGNETO-RESISTANCE (MR) DEVICES. Magneto-resistance occurs when a magnetic field applied to a semiconductor, changes the resistance of the semiconductor and thus the current that can flow through it. There are

THE GIANT MR is commonly used in the read-write heads of modern high-speed disc memories. A usual design is to build two ferromagnetic layers that sandwich a layer of non-ferromagnetic semiconductor. The magnetism of one ferro layer is a fixed magnet and an outside field orients the other layer, perpendicular to it. When the magnetic fields of the two layers are parallel, the resistance of the inner layer is very low and a large current flows. The resistance change is very fast - about 0.1 nanosecond permitting rapid data entry and retrieval.

Recently an even faster MR has been found (Scientific American, July 2004) termed **Extraordinary MR** (EMR) that depends on the geometry of the 3 layers, one of which is a conductor between the two semiconductors. This produces a time constant of about 0.001 nanosecond, 100 times faster. An imposed magnetic field causes electrons to travel spiral paths thus lengthening the travel time between collisions and increasing the resistance.

It is well known (See Carver Meade, 2000) that the usual equations for magnetism are a poor approximation so that using the WSM, better calculations can be made of the magneto-resistance effect.

BIOLOGY AND GENETICS. The techniques of manufacturing semi-conductors are beginning to be applied to building organic devices using biological parts. It is possible (*Engineering Life*, Scientific American, June 2006) to synthesize DNA strands from their constituent basic four molecules: adenine (A), cytosine (C), guanine (G) and thymine (T).

Although DNA is a very long molecule – millions of basic units – the basic units are just two simple pairs of the basic four molecules: AT and CG. These unit-pairs form the rungs of the enormous DNA ladder molecule. It is amazing that the genetic code that contains the key instructions to grow every form of life is contained only in the billions of possible arrangements of the millions of pairs on the ladder. How did Nature learn and arrange the mathematics of probability that distinguishes one living organ from another – an ear from a tooth, for example? Again we see that Nature is binary, and that complexity in Nature arises out of simplicity.

How did Nature find this scheme of mathematics that underlies the evolution and growth of life? It is even more amazing when you realize that the wave-bonds between molecules must have just the correct exchange energy to hold them together and yet, when necessary in the growth of an egg into a living organism, the bonds can be separated as required in the presence of other molecules, acids, and bases. Not just any molecule will do – they must be just right in ways that we do not yet understand. Biochemistry science does not yet evaluate the energy of bonding schemes. Standard chemistry merely describes the arrangements of molecules and their behavior. This is because the bonds are *wave structures* not yet widely used. The use of the WSM may provide greater understanding of the growth of life.



INDUSTRIAL ALLOYS. Most of the valuable varieties of metallic alloys – steel, brass, dura-aluminum, etc. that are widely used in industrial applications are simple mixtures of the basic elements – iron, carbon, copper, zinc, aluminum, etc. Their properties have been discovered by trial and error over centuries of smithing, weapon building, and industrial metallurgy. In principle, if one knew the way the elements of the mixture joined together, we might be able to design alloys for specific purposes instead of using trial and error. This is now possible because the alloy bonds are *wave structures*.

ENERGY STORAGE DEVICES. The common flashlight ‘battery’ and the sophisticated storage devices of the modern hybrid car are chemical mixtures of two elements whose binding energies are different. The difference is the voltage of the battery. Just like the history of alloys, these energy differences are empirically measured, as well as the behavior and stability of the two elements. Again, if one knew the way the elements of the mixture joined together, we might be able to design batteries for specific purposes, by calculation using the WSM.

The future of the WSM will require new techniques of application, calculation, and design. These applications in the future are for you the reader. But I hope I can help!

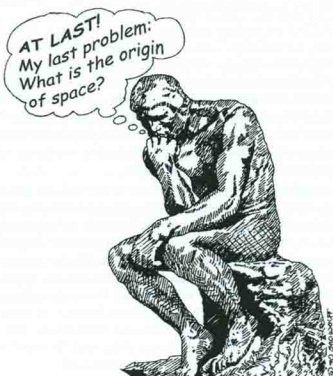
THE FINAL SINGLE TASK of theory is to understand the origin of space. What is space? Why does it have the strange feedback property also found prominently in General Relativity? This is the final frontier, illustrated below.

Good luck.

What is the origin of space?

We know almost nothing about it except its two properties; Principle I and II. Perhaps we are not entitled to ask more since these two properties lead to all our fundamental knowledge of matter and the natural laws.

The most perplexing aspect is its self feed back; that the density of space determines the form of matter (wave-centers), and conversely, every wave-center (matter) contributes to the density of space in the Universe. If there is a God, this is it.



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Internet Encyclopedia: en.wikipedia.org/wiki/Wave_Structure_Matter

"Wave Structure of Matter": www.SpaceAndMotion.com This most complete site broadly discusses, the WSM, its history and philosophy.

Dean Darger: www.dargerresearch.com/products.html Beautifully shows in 3D animation, the correct H atom waves computed from Schrödinger's Equation.

Mike Weber: www.ryanbagan.net/mike/StandingWave3D/StandingWave3D.htm An insightful and informative 3D animation of the wave-center of the electron. User can choose values of: time, Doppler speed, and other electron interaction parameters.





Erwin Schrodinger (1937)
perceived that the whole Universe,
what we observe as material bodies
and forces, are nothing but shapes
and variations in the structure of space.
When he and Einstein debated the
particle theorists led by Neils Bohr,
most scientists thought they had lost it.
This book shows they were right; that
all matter is one Wave Structure in the
space of the Universe. If the stars did
not exist, we could not exist.

"This book peers into the foundations of science, particles, and the natural laws,
and relates them to the enigmas of the Universe." — Tom Gehrels, University of Arizona

"Dr. Wolff, an Apollo researcher at MIT, writes an exciting, reader-friendly
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Milo Wolff is a researcher in astronomy and has been
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Wolff theory of the Polarization of Reflected Light was
republished in a series entitled "Milestones in Optics"
by the International Society for Optical Engineering.

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